

THE
AGRICULTURAL BULLETIN
OF THE
FEDERATED MALAY STATES.

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EDITORIAL NOTES.

STAFF APPOINTMENTS AND CHANGES.

Mr. L. Lewton-Brain, Director of Agriculture, F.M.S. and S.S., proceeded on long leave on 2nd May. Mr. F. W. South was appointed to act as Director from that date until 23rd May when Mr. B. J. Eaton took up the Acting appointment.

Mr. B. J. Eaton, O.B.E., Agricultural Chemist, returned from long leave on 23rd May.

Mr. A. G. G. Ellis, Assistant Agricultural Inspector reported his return from long leave on 22nd April. He proceeded to Johore Bahru on 19th May to take up the duties of Agricultural Inspector, Johore.

Mr. W. N. C. Belgrave, Plant Physiologist, returned from long leave on 15th June.

Mr. V. R. Greenstreet, A.I.C., reported his arrival on 23rd May and assumed duties as Assistant Agricultural Chemist.

Mr. J. L. Minto, reported his arrival on 24th May and assumed duties as Assistant Agricultural Inspector.

Mr. A. A. Campbell, reported his arrival on 20th June and assumed duties as Assistant Agricultural Inspector.

Mr. Malcom Miller has been appointed a Temporary Assistant Mycologist, he assumed duties on 17th May, 1921.

AGRICULTURAL EDUCATION.

This number of the bulletin contains reports on agricultural education for Malaya. In view of the recommendations put forward, the following extract from Colonel Amery's speech in the House of Commons on 30th July, 1919, on the Colonial Office Supply Bill is of interest:

"I spoke just now of the desirability of educating the native. That is one of the greatest problems before us, and one in respect to which we are only at the very beginning of what we ought to do. There is a very large task before us, both in general

education and, perhaps more particularly, in practical education in agriculture. We want to strengthen all our Agricultural Departments. We want to start, for study and research, agricultural colleges, or universities, if you like, which will be the centres from which new ideas and better methods will be diffused to all the surrounding Colonies. It is a matter about which there was a good deal of talk before the War, but, like many other things, it inevitably had to wait. I hope now to take up the matter again, in the first instance with the West Indies, and I hope also elsewhere in the tropical Empire, so that in this respect, as in others, we may be able to give a lead to other Administrations. I may mention in this connection that we have been fortunate in securing from the Treasury a grant of £20,000 a year for special research work in those Colonies which are not able to do research work themselves, on the lines on which very much larger sums have been granted for research work in this country."

SLAB RUBBER.

Renewed interest in Slab rubber is being taken by American buyers, and small forward contracts have been arranged on the understanding that all consignments of the commodity shall be sold on a certificate of quality given by the Agricultural Department.

" UNDERCURED " SMOKED SHEET.

Apart from the actual values which have been determined for the moisture content of smoked sheet and its bearing on industrial problems the article on "Undercured" smoked sheet published in this bulletin is significant of the present state of rubber valuation.

According to the statement of the Chairman of the Singapore Chamber of Commerce a deduction of a quarter cent per lb. was made on a certain parcel of smoked sheet because in the opinion of a board of arbitrators the sheet was internally damp. A sample taken from this parcel by the Chamber of Commerce was subsequently submitted to the Acting Agricultural Chemist for examination and report, with the result that the sample was found to contain only 0.14 per cent. of internal moisture and was perfectly normal in every respect.

The absence of exact standards for valuing rubber is bound to lead to these cases of injustice and the importance of such work as that on moisture content in smoked sheet in establishing definite criteria for judging rubber cannot be too strongly emphasized.

In this connection, although in some cases managers of estates are rightly blamed for defects in their product, when these defects are obviously due to lack of care in preparation, in other cases the cutting off by the broker of a cent or two per lb. on the

value of the rubber is unjustified. In the "Tin and Rubber Journal," Volume X, No. 11, of 15th June, 1921, the editor appears to agree with the brokers and agents in Singapore and suggests that the agents do their very best to obtain the highest prices for the rubber sent them.

From information received from reliable sources, it is doubtful whether this is so in many cases. In numerous instances samples of rubber rejected as first quality by the brokers in Singapore on account of so called defects, have been referred to the Agricultural Department and found to be of excellent quality. The point at issue is really the methods of valuation.

The Agricultural Department is always prepared to give an opinion based on vulcanization tests and from experience, in connection with samples which have been rejected in Singapore. In several instances the opinion of the broker has been found entirely at variance with the actual value of the rubber to the manufacturers.

PESTS AND DISEASES OF PLANTS.

During the past few months the Government has given considerable attention to the possibility of a rapid increase of pests and diseases on rubber lands which have been abandoned or neglected by owners no longer in a position to raise the money necessary for their adequate up-keep. The normal staff of inspecting officers is capable of guarding against this danger to the extent of ascertaining fully and frequently the amount of disease present in any part of the country; it has been recognized however, that special government provision may be necessary to meet the present situation and the following is a brief outline of the measure it is proposed to adopt:

Under the supervision of officers of the Inspection Division, a number of temporary posts will be created. These officers will be put in charge of pest gangs and will be allotted districts which they will work regularly through, and when it is found impossible for an owner to carry out control of disease on his property this will be undertaken by government and the cost of such treatment recovered from the owner either at the time of treatment or at such future date as he may be able to pay. In the event of his being quite unable to bear the expense, this will be met from Government Funds.

The introduction of nursery stock either in the nature of seed or plants even if the particular kind of stock exists in Malaya is attended by risks and in the near future it may be necessary to consider the advisability of legislating with regard to the importation of plants so as to protect particular cultivations from the ravages of insects.

The difficulties attending the suppression of insects are so great that to prevent them being introduced should be the aim of all associated with the welfare of agricultural enterprises.

Legislation may take the form of (1) entirely prohibiting

- (a) the entry of special plants from a country where a serious pest is known, or owing to their liability of carrying a number of pests;
- (b) the introduction of plants unless a certificate of freedom from insects from the Agricultural Department of the exporting country has been given.

(2) enforcing the quarantine of all plants which would have to be planted or kept at a Quarantine Station for examination before forwarding to the consignees; and

(3) fumigating where necessary all plants at the port of entry.

Provision for the inspection of all plants at the port of entry is most important and the destruction of infected plants would have to be left to the discretion of the examining officers.

During the past two months enquiries have been received with regard to insects attacking several different plants.

Practically all plants suffer from the depredations of one or more insects and the pioneer cultivators should always be on the *qui vive* for injurious insects.

On the first appearance of noxious insects immediate action should be taken to prevent their spread and to minimize their injury. Frequently if simple measures, such as collecting, are taken when insects are first noticed they can be controlled, but if they receive no attention they may increase to such proportions that little can be done to save the crop.

The Agricultural Department has information concerning most of the insects affecting crops in other countries, the probability of similar pests being met with on similar plants in Malaya, and the preventive and remedial measures which should be employed.

Planters are informed that the Red Stripe Weevil (*Rhynchophorus schach*, Oliv) has been found on the trunk of the African Oil Palm, 17 days after stem pruning, and are warned against pruning the stems too severely.

The Mycological Division is at present devoting most of its time to the study of Bud Rot of coconuts and it is hoped shortly to publish a special Bulletin containing observations on the disease in Malaya—a similar "Bud Rot" in oil palm is also receiving considerable attention.

A number of diseased specimens of *Hibiscus Sabdariffa* var. *altissima* ("Roselle Fibre" plant) has been examined and two distinct series of symptoms have been found—in one it appears that eel-worms are the primary cause of the trouble, but the other shows a bacterial infestation of the water-conducting vessels. A bacterium has been isolated, and inoculation experiments will be started as soon as possible, to ascertain whether this is the cause of the disease.

Mr. W. N. C. Belgrave, Plant Physiologist, spent a few weeks during his long leave in British Guiana, studying the serious South American Leaf Disease of Hevea, caused by a fungus (*Melanopsammopsis Ulei*). A full report of this important visit will be published in the next number of the Agricultural Bulletin.

AGRICULTURAL SHOWS.

In the general conduct of District Agricultural Shows, it would seem that insufficient effort is made to advertise amongst the Chinese and Tamils. Many shows fail to attract entries from estate coolies, although it is known that the Tamil coolies, on many estates, have well-conducted plots. The interest and support of well-known public-spirited Chinese gentlemen together with a certain amount of literature printed in the Chinese language should help considerably; while the attention of managers of estates should suffice to advertise the shows in the case of Tamil exhibitors.

Many other points on organization require attention. For instance, at many shows padi exhibitors are asked to bring two "gantangs" (gallons) of each exhibit of padi,—whereas the judges require only one-eighth of this amount.

The Department of Agriculture will be pleased to help in the arrangements for District Shows; it is generally possible to supply one officer for the Committee, and often a judge for the more important sections. Organizers of Shows are invited to communicate with the Department for assistance in this connection, so that full use may be made of the experience of the Department, and that the educational value of District Shows may be kept to the fore as the justification of Government contributions for this purpose.

DISTRIBUTION OF PLANT MATERIAL.

During the quarter there has been a large demand for planting material of various economic products and cover plants. This demand has been met when possible and applicants have been referred to sources of supply in other cases. Addresses of firms who can supply seed, in quantity, of the African Oil Palm, Giant Mimosa, and *Centrosema Plumieri* have been obtained. An enquiry has also been sent to the Bureau of Agriculture, Manila, regarding the cost of importing suckers of Manila hemp from the Philippines.

OIL PALM.

Mr. J. N. Milsum, Assistant Agriculturist, spent a fortnight in Sumatra visiting plantations and studying the cultivation of the African Oil Palm. Considerable information on artificial pollination, pruning and yields of the Oil Palm was obtained, also information on soil conservation and green manuring. A detailed report of this visit is published in the present number of the Agricultural Bulletin.

ROSELLE FIBRE.

Commenting on the cultivation of *Hibiscus Sabdariffa* var. *altissima* (Roselle) the Director of Agriculture to the Government of the Philippines writes.

"Neither this particular variety of roselle nor any other is cultivated in the Philippines on a commercial scale. The Roselle has a more deep growing root system than most annual crops, and the land should therefore be deeply ploughed and spaded and the soil pulverized preparatory to planting. The seed should be sown thinly in drills 30 cms. apart in the row.

"The seeds are sown here in May, the beginning of the rainy season, and the plants mature in 250 to 269 days."

“UNDERCURED” SMOKED SHEET.

By R. O. BISHOP.

UNDER the title of “Undercured Rubber” the problem of moisture in smoked sheet has been receiving attention recently in the periodicals devoted to the interests of the rubber industry, and reference to the “Tin and Rubber Journal” of 15th June will show that there is a considerable difference of opinion as to the justification of the claims made by the brokers in Singapore.

For the investigation of claims arising in connection with so called “undercured” sheet the examination of a series of samples was carried out by the writer in October, 1920, at the original request of the Chairman of the Singapore Chamber of Commerce. Since then many other samples have been examined and several reports have been issued in connection with the work carried out. It appears now that a useful purpose might be served by summarizing all the results obtained and permanently recording the observations which have so far been made on the work already performed.

Having defined an undercured sheet as that which possesses more internal moisture than a correctly cured sheet (*N.B.* The term has also been used previously in connection with a light coloured smoked sheet) it was established by the rubber appraisers, and upheld by the Singapore Chamber of Commerce, that undercured rubber could be distinguished by the opacity exhibited at a freshly cut section when viewed against bright daylight.

It was asserted that any samples of smoked sheet giving a plainly marked opaque section were abnormally damp, would develop mould, and also would give unusual trouble to the purchasers when the rubber come to be manufactured into the vulcanized commodity.

The investigation, therefore, resolved itself into a determination of the relative amounts of moisture in smoked sheet as it is normally prepared, and then an examination of the effects which these percentages of moisture would have on the ultimate properties of the rubber concerned.

RELATIVE AMOUNTS OF MOISTURE IN CORRECTLY “CURED” AND IN “UNDERCURED” SMOKED SHEET.

Methods of Determination of Moisture.

In the original instance thirteen samples of sheet were examined. The moisture was determined by two methods.

By the first method the sample cut to a standard area of surface was suspended from a glass rod over calcium chloride in a vacuum dessicator. The dessicator was kept in the dark and all weighings were made on the samples at the same time of day so that any error due to variable atmospheric humidity would be

eliminated as far as possible. Moreover as the weighings were done in fairly rapid rotation, surface adsorption during weighing should be the same for all samples.

By the second method drying of the standard sized sample was accomplished by suspending it in a current of dry air at 80° C. in the dark.

In the case of both methods the samples were weighed every 24 hours until no further loss in weight occurred. The maximum loss was expressed as a percentage on the original weight and described as "Total Moisture."

It must be noted that as the smoked rubber contains certain adsorbed and absorbed volatile smoke products the figure for total moisture will be too high by the amount of such volatile matters originally present.

Having dried the samples to minimum weight they were then allowed to remain in the air for 24 hours under protection from dust, etc., and all samples were then retained in a dessicator until it was possible to expose them all to the air during the same 24 hours. Thus the humidity of the atmosphere had the same effect on all. The difference between the weight before exposure and the weight after exposure is expressed as a percentage on the original weight of the sample and is described as External moisture."

The difference between the "Total moisture" and the "External moisture" is described as "Internal moisture" and is a measure of the undercuring of the sample.

For the purpose of the subsequent discussion of results the samples examined have been arranged according to the degree of opacity which they exhibited. The arrangement being made by an impartial observer.

Sample No.	Loss by desiccation at ordinary temperature "total moisture."	Moisture taken up on exposure to air "surface moisture."	Difference "interior moisture."	Average.	Loss at 80°C in current of dry air "total moisture."	Moisture taken up on exposure to air "surface moisture."	Difference "interior moisture."	Average.
NO OPACITY.								
1	0.53	0.43	0.10	0.10	0.65	0.48	0.17	0.17
VERY FAINT OPACITY.								
2	0.68	0.48	0.20		0.76	0.51	0.25	
3	0.59	0.46	0.13		0.63	0.46	0.17	
4	0.62	0.49	0.13	0.15	0.73	0.56	0.17	0.20

Sample No.	Loss by dessication at ordinary temperature "total moisture."	Moisture taken up on exposure to air "surface moisture."	Difference "interior moisture."	Average.	Loss at 80°C in current of dry air "total moisture."	Moisture taken up on exposure to air "surface moisture."	Difference "interior moisture."	Average.
SLIGHTLY MORE OPAQUE.								
5	0.46	0.39	0.07		0.48	0.34	0.14	
6	0.63	0.49	0.14		0.66	0.47	0.19	
7	0.53	0.43	0.10		0.65	0.48	0.17	
8	0.57	0.45	0.12		0.86	0.68	0.18	
9	0.56	0.43	0.13	0.11	1.26	0.91	0.35	0.21
MORE, BUT NOT PRONOUNCED OPACITY.								
10	0.57	0.45	0.12	0.12	0.63	0.42	0.21	0.21
PRONOUNCED OPACITY.								
11	0.85	0.64	0.19		0.89	0.76	0.13	
12	0.54	0.43	0.11	0.15	0.59	0.47	0.12	0.13
VERY PRONOUNCED OPACITY.								
13	0.54	0.32	0.22	0.22	0.62	0.46	0.16	0.15

The average for internal moisture on the complete series of samples is 0.18 per cent.

From these figures it was apparent that the total volatile matter present in smoked sheet was of the order of 0.6 per cent. and of that total approximately seventy five per cent. was held at the surface of the sheet. The average figure for the interior "Moisture" even when the samples were dried at 80° C. was 0.18 per cent. only.

As was to be expected the heating of the rubber resulted in a greater loss than by dessication at atmospheric temperature, but although this heating was as intense as the maximum reached in working up raw rubber for subsequent vulcanization the total loss of volatile matter amounted to 0.71 per cent. on the average and in one case only was above 1.0 per cent. Ref. Archief VV 1921. "Moisture content of inner and outer layers of smoked sheet" by van Heurn.

Another point which was obvious was that the slight differences in moisture content, total or internal, did not bear any relation to the opacity of the interior of the sheet examined.

The results which have been obtained in this series are in agreement with the figures derived from several isolated examinations of smoked sheet but it was not considered that a definite confirmation had been obtained until a second long series of samples had been examined.

Eighteen samples were eventually submitted by the Orient Co., of Singapore and were examined in conjunction with pieces of unsmoked sheet and No. 1 crepe. Before sending the rubber for examination it had been classified in Singapore by the "Opaque appearance" method and for every sample having the correct internal appearance there was a corresponding sample from the same estate having an internally opaque appearance and consequently characterized as internally moist and undercured. The "dry" samples were numbered 1, 2, 3 and 4, etc., the "wet" samples were numbered 1a, 2a, 3a and 4a, etc.

The method of examination adopted was the dessication at atmospheric temperature, care being taken that all samples should be treated exactly alike. Dessication was continued for the same length of time—288 hours—but it was found that much shorter periods were sufficient to reach the maximum loss in the majority of cases. When the samples had all lost their maximum amount of volatile matter the increase in weight after exposure to atmospheric conditions was determined as before.

RESULTS.

Sample.		Time taken to reach minimum weight.	Total loss of weight per cent.	Internal moisture per cent.	Surface moisture per cent.
Smoked Sheet.	1	96 hours.	0.41	0.16	0.25
	1a	72 "	0.42	0.07	0.35
	2	48 "	0.45	0.02	0.43
	2a	96 "	0.69	0.28	0.41
	3	144 "	0.51	0.15	0.36
	3a	96 "	0.41	0.05	0.36
	4	144 "	0.55	0.23	0.22
	4a	144 "	0.78	0.34	0.44
	5	72 "	0.52	0.48	0.04
	5a	144 "	0.53	0.00	0.53
	6	144 "	0.50	0.19	0.31
	6a	144 "	0.51	0.24	0.27
	7	96 "	0.48	0.15	0.33
	7a	120 "	0.61	0.20	0.41
	8	72 "	0.51	0.00	0.51
	8a	144 "	0.68	0.27	0.41
	9	120 "	0.59	0.22	0.37
	9a	96 "	0.52	0.16	0.36
Un-smoked Sheet.	10	288 "	1.05	0.16	0.89
	11	288 "	1.40	0.11	1.29
	12	288 "	1.08	0.35	0.73
	13	216 "	0.36	0.02	0.34
Crepe.	14	264 "	0.24	0.00	0.24

REMARKS ON RESULTS.

The average figures obtained for the total volatile content of the 18 smoked sheet samples was 0.53 per cent. which is in agreement with that found by the previous determinations.

The average figure for surface moisture or volatile matter was 0.35 per cent. on the smoked sheet.

The average figure for Internal moisture or volatile matter was 0.18 per cent. on the smoked sheet samples.

The total loss on dessication is greater for unsmoked sheet than for either crepe or smoked sheet but even when the total volatile matter amounts to 1.40 per cent. it is found that 92 per cent. of the amount is on the surface.

In dry crepe which is immediately to be mixed with sulphur preparatory to vulcanization the surface moisture may be as high as 0.34 per cent. and the average figure for smoked sheet was only 0.01 per cent. above this.

In this connection attention is called to the very interesting figures published by O. de Vries Arch. 2, (1918), 852 on the variation in moisture content of crepe and smoked sheet during the dry and wet monsoons. Dr. Vries gives 0.34 per cent. to 1.0 per cent. for the normal limits of moisture in crepe and 0.43 per cent. to 1.70 per cent. for the normal limits of moisture in smoked sheet.

The work of Miss Krayenhoff Van der Leur Comm. Delft II page 41 has also shown how considerable are the variations of moisture in raw rubber due to variations in atmospheric humidity. G. S. Whitby—J. S. Ch. I. (1918) 280 T.—has also shown that owing to the absorptive nature of the rubber surface, moisture may be retained to the extent of 1.4 per cent.

CONCLUSIONS.

The conclusions to be drawn from the above may therefore be summarized as follows:

1. All smoked sheet contains moisture. This may amount to 1.0 per cent. without being abnormal, and on the average is about 0.5 per cent.
2. Of the total moisture in smoked sheet the greater proportion i.e., about 70 per cent.—is held as surface moisture. This is apparently held in an adsorbed state and consequently is subject to variation. The variation is dependent on the atmospheric humidity and on the amount of serum solids left in the finished sheet. (See page 606 "Estate Rubber" by Dr. O. de Vries also remarks of van Heurn Archief IV, 1921.)
3. The examination of the samples submitted did not demonstrate that there was any significant difference in total moisture between those samples with opaque inner sections and those samples without opaque inner sections.

4. The opacity was not a characteristic of high internal moisture, for it was found that the average internal moisture content for the opaque sheets 1a, 2a, 3a, and 4a, etc., was 0.18 per cent. and the average internal moisture content for the non-opaque sheets 1, 2, 3 and 4, etc., was also 0.18 per cent.

LIABILITY OF SMOKED SHEET TO DEVELOPMENT OF MOULDS.

With regard to the second portion of the investigation, namely to determine the effects of the moisture content in smoked sheet it was thought to be sufficient for the present to examine the samples from above to see if there was any noticeable difference in their propensity to mould development, and if so, whether such was related to their internal moisture.

Portions of the fresh samples were suspended in the air so that the conditions were the same throughout and they were examined daily to see which sample showed the first appearance of mould. The following table gives the samples arranged in order of internal moisture and in order of mould development and also in order of depth of opacity of internal section as judged by a rubber technologist.

Order of total moisture.	Order of internal moisture.	Order of mould development.	Order of opacity.
4a	5	4a	9a
2a	4a	2a	5a
8a	2a	8a	5
7a	8a	5	6a
9	6a	3a	4
4	4	4	7a
5a	9	8	9
9a	7a	7	8a
5	6	7a	2a
6a	9	...	3a
6	1	...	4a
3	7		
8	3		
7	3a		
2	2		
1a	1a		
1	5a		
3a	8		
		Remainder not mouldy.	Remainder not apparently opaque.

There does appear to be some relation between internal moisture and order of mould development but the relation is not very marked and as the same order persisted on the samples after they had been completely dried, and again allowed to develop mould it would appear to be probable that the substances in the rubber which promote mould growth serve to increase the moisture content and it is not the moisture of the rubber which gives rise to mould.

It may be noted here that another investigation is being conducted on the nitrogen content of the samples in order to settle this point, so far however no definite results are available.

VULCANIZING CAPACITY.

With regard to the vulcanizing properties of the samples of smoked sheet and the tensile properties of the vulcanized products the results showed that the amount of moisture contained even in the wettest samples had no apparent effect.

The differences in total moisture between the wettest and the driest samples did not persist when the samples were broken down during the sulphur mixing, and the internal moisture in all the samples of smoked sheet examined was apparently a negligible factor.

It will be of interest to determine to what extent moisture in crude rubber may be lost during working on the mixing rolls. No definite figures are yet available for publication, but the preliminary work in this direction has shown that while being masticated and mixed preparatory to vulcanization moist rubber can be deprived of considerable quantities of water without the necessity of enduring abnormal heating or rolling and it appears that even the total moisture in the most "undercured" samples of smoked sheet now sold on the market cannot persist after mastication and consequently will have no detrimental effects on vulcanizing properties of the rubber.

REVIEW.

PLANTATION RUBBER AND THE TESTING OF RUBBER

By G. STAFFORD WHITBY, PH.D., M.Sc., A.R.S. SC.,

Assistant Professor, Department of Chemistry, McGill University.

*Published by Longmans Green & Co., 39, Paternoster Row, London
559 pages, including bibliography and index, 56 illustrations
including 8 plates and 48 figures and diagrams.*

THIS book, constituting one of the monographs on Industrial Chemistry edited by Sir Edward Thorpe, C.B., LL.D., F.R.S., is undoubtedly the best book which has been written on this aspect of the Plantation Rubber Industry, apart from the special bulletins on similar problems which have been published by the Department of Agriculture, F.M.S. and S.S., the Department of Agriculture, Ceylon, in conjunction with the Imperial Institute and the Rubber Testing Station of the Netherlands East Indies in Java. Much of the information in the first part of the book is compiled from the above-mentioned bulletins and the selection of Dr. Whitby as the writer of this monograph was fortunate, since he was in close touch for several years with the work done in the Eastern tropics on the problems discussed, in his former position as Chief Chemist and Technical Adviser to one of the largest plantation organizations in the East—the Société Financière et des Caoutchoucs.

Although the author has compiled much of the work in his book, the reviewer knows from his personal contact with Dr. Whitby that he had arrived at many of the conclusions reached by the reviewer in his researches on raw rubber, although in the position of Technical Adviser to a private company he was unable to publish much of the work done by him.

The bibliography is very considerable and much time and trouble must have been taken by the author in connection with the references to the literature quoted.

The illustrations and diagrams are excellent. The latter portion of the book, devoted to the testing of rubber, should be of great assistance to research workers engaged in rubber investigations of this nature.

The composition and nature of latex is fairly fully discussed, as far as our knowledge goes. A chapter is also devoted to the very important problems of seed selection and variation in yield of individual trees, in which investigations Dr. Whitby interested himself at an early date.

There are few important criticisms which can be made. The author is probably somewhat biassed by his own investigations in connection with the factors responsible for the coagulation of latex under anaerobic conditions, and adheres to a strictly enzyme hypothesis, whereas the reviewer considers that the work of

Vernet and Denier in Cochin China, in which natural anaerobic coagulation is attributed primarily to bacteria cannot be ignored and must be accepted until it has been disproved.

Another minor criticism might be made in connection with a foot note on page 144, referring to the use of alum as a coagulant, in connection with which legislation prohibiting its use has been introduced into the Federated Malay States on the reviewer's recommendations. In this foot note the author states that "the total amount of rubber produced on small holdings is relatively only small.

The reviewer who, in his official capacity, is more in touch with the small holder, must disagree with this statement. The amount of rubber produced by the small holders (including estates under 100 acres) is relatively large and the use of alum as a coagulant has become an important question. American buyers in particular had referred to its effects on the raw material.

The book should be in the hands of all rubber research workers, rubber chemists, estate managers and others connected with the plantation industry.

B. J. E.

CHEMICAL NOTES.

VEGETABLE OILS AND FATS.

A FURTHER series of experiments on the development of acidity in Palm Oil has been carried out which show that if fresh clean fruit (kept up to five days after picking) be heated to a temperature not exceeding 100°C. before extraction, the acidity of the resulting Palm Oil (calculated as palmitic acid) can be kept below 2 per cent. (*See communication from General Experimental Station A.V.R.O.S. June, 1921.*) A further series of experiments will be carried out to determine the minimum time of heating in this figure.

An enquiry has been received as to whether the seeds of *Centrosema Plumieri* are of any value from the point of view of oil content. This investigation is not yet complete but it is hoped to summarise the results in the next number of the Bulletin.

ESSENTIAL OILS.

Work on Citronella Oil has been continued and the samples of the oil obtained from the grass growing in Government Plantations have been forwarded to the Malay States Information Agency in London for report and valuation. It has also been decided to forward a large quantity of this oil (about 2 gallons), to the Agency with a request that it may be sold on the London market in order to ascertain whether it will be possible to render the production of this oil a profitable proposition.

It has been found, by the method of steam distillation in use here, which can be easily adopted by an estate, that the sun-dried grass yields 0.7 per cent. of a good quality oil. A sample submitted for local valuation has been classified as superior to the Java Oil now on the market.

PEAT DISTILLATION.

Further investigation has been carried out in connection with the distillation of peat for the production of acetic acid. It was at first supposed that, owing to the variable results for the ammonia content of the distillate, the original peat during drying underwent fundamental changes involving loss of nitrogen. It has now been shown however that there is no variation in nitrogen during drying; also that under the local atmospheric conditions it is possible to remove 88 per cent. of the moisture originally contained, by air-drying for one week. This is a great initial advantage, which any process for peat utilization would have over a process developed in Europe.

The dry peat was found to contain 1.35 per cent. of nitrogen and 80 per cent. of organic matter and should on distillation yield more than one pound of pure ammonia gas per cwt. of material in addition to the acetic acid produced.

Suitable supplies of peat have been obtained and it has been arranged to continue the investigation on a semi-technical scale.

MISCELLANEOUS.

A sample of jungle fruit, Perpet Paya, belonging to the family of Olacinae was submitted for investigation by the Forest Department for oil content. It was found that this fruit did not belong to an oil bearing variety but that it contained a very bitter principle which remains to be investigated.

Analyses of the residues from exhausted African Oil Palm pericarp and African Oil Palm kernels show that the former is of little value but that the meal from the latter contained up to 20 per cent. albuminoids, and low fibre content. Trials with this material as a feeding cake do not seem to be worth carrying out in this country at present.

R. O. B.

THE AFRICAN OIL PALM IN SUMATRA.

By J. N. MILSUM.

DURING May of 1921, a visit was made to the east coast of Sumatra for the purpose of obtaining information relating to the position of Oil Palm cultivation in that country. The present paper embodies observations made during the visit with comments arising from experiments conducted with this crop in the Federated Malay States.

AREA UNDER CULTIVATION.

Though statistics are not available it is estimated that the present planted area of oil palms on the east coast of Sumatra is approaching 25,000 acres. According to the 'Statistics of the Export of Rubber, Coffee, Tea, Copra and Palm Oil' published by the Medan Chamber of Commerce, 491 tons of palm oil were exported during the first half of 1920, so for the purpose of calculation it may be estimated that 1,000 tons of oil were produced for export for the year. Dr. Rutgers, Director of the General Experimental Station of the Algemeene Vereeniging van Rubberplanters ter Oostkust van Sumatra, estimates that within 10 years the planted area will have been increased to 100,000 acres producing, when in bearing, 100,000 tons of palm oil per annum. The total export from West Africa during 1920 may be taken to be about 130,000 tons of palm oil and 400,000 tons of kernels. Owing to unsatisfactory machinery and high costs of treatment, it is considered hardly worth while exporting kernels from Sumatra at present.

ORIGIN OF THE OIL PALM IN SUMATRA.

The oldest palms are said to be at St. Cyr Tobacco Estate in the Langkat district; the first palms were planted in 1884 from seed imported from Singapore Botanic Gardens. Dr. Rutgers states that by far the greater number of the palms on the east coast are derived from seeds from these old palms at St. Cyr. Many of the palms are now 37 years old and when examined, during my visit to the estate, showed no signs of old age and were bearing good bunches of fruit, especially where artificial pollination had been undertaken. The height of these palms has been recorded and is stated to be from 50 to 60 feet. Other seed has been obtained from Buitenzorg Gardens and ornamental palms in Java. The oil palms seen in Sumatra, as would be expected, are fairly uniform in habit and are known locally as the Deli type. Palms raised from seed recently imported from the Congo, have in many cases proved inferior in respect of thickness of pericarp and are known as the Congo type.

PRESENT SOURCE OF SEED SUPPLY.

Until further investigations have been undertaken to determine what is the most desirable variety of palm for cultivation in the East, it is evident that the Deli type generally met with throughout Sumatra and established at the Experimental Plantations, Kuala Lumpur, and on several estates in the Federated Malay States, is the type to be planted at the present time. Seed from selected palms may be obtained in quantity from several estates on the east coast of Sumatra.

VARIETIES.

As already indicated work in Sumatra with regard to the varieties of oil palms is not far advanced but is now receiving the attention of the General Experimental Station of the A.V.R.O.S. The main features for determining the value of oil palms are:

- (1) The number of bunches of fruit per annum. The palm should produce a large number of female spikes.
- (2) Size of bunch.
- (3) Number of fruits per bunch.
- (4) Thickness of pericarp and oil content.
- (5) Thickness and hardness of shell.
- (6) Size of kernel.

The Deli type already referred to produces the largest fruit of the forms cultivated in Sumatra and var. *pisifera* the smallest; the latter having practically no shell. It is to be appreciated that the shell of the kernel is a waste product and should be as thin as possible so as to be cracked with a minimum of motive power.

The three varieties now producing fruit at the Experimental Plantations, Kuala Lumpur, received from the Department of Agriculture, Southern Nigeria early in 1914 are not under cultivation in Sumatra and material of the under-mentioned varieties has been asked for by the scientific officers of the Experimental Station of the A.V.R.O.S.

Elaeis guineensis var *microsperma*.

„ var *communis* (Ope-pankoro).

„ var *idolatrix* (King or fetish palm, Ope Ifa of Ibadan).

As fruit becomes available the value of these varieties will be determined here with a view to their extended propagation.

CULTIVATION.

Climatic conditions.—As far as can be ascertained the climate of the east coast of Sumatra is similar to that over here and from a comparison of the rainfall records published in the 'Regenwaarnemingen op Sumatra's Oostkust' issued by the Deli Proefstation with those available in this country, a general similarity is to be noticed.

The equatorial climate of the East Indies is undoubtedly favourable to the growth of oil palms. Most of their growth is made during rainy weather when the majority of the fruiting spadices are formed. The rate of growth of the palms in Malaya and Sumatra appears to be about the same, though in the latter country on the 'tufa' soils of volcanic origin, stouter and more vigorous palms are seen than usual.

Elevation.—Although the oil palm grows well on low-lying land, provided adequate drainage is afforded, it also grows and yields well up to 2,300 feet in the Cameroons, and in Sumatra at Marihat Baris Estate in the Siantar district a very fine avenue of palms was seen at an elevation of over 1,100 feet. The palms number in all about 130 and are planted $26\frac{1}{2}$ feet apart. The growth of the palms is excellent and equal to if not more than that of eight year old palms on the plains. The crop records for the palms on Marihat Baris Estate for the year 1919 have been collected and published as Appendix VIII in the 'Communications of the General Experimental Station of the A.V.R.O.S.' General Series No. 8. From the mass of yields recorded the following table is compiled.

AVERAGE YIELD PER PALM IN LBS. DURING 1919.

Number of bunches.	Weight of bunches.	Weight of fruits.	Weight of pericarp.	Weight of nuts.
9.25	30	21	10.4	10.6

The soil in the locality is good and on the strength of the behaviour of these palms, one estate in the district is pushing on with a programme of planting 5,000 acres of oil palms at this elevation. At the time of my visit about 2,000 acres had recently been planted and the young palms looked very healthy.

During my stay in this district I was shown the planted and reserve area of the Rubber Plantations Investment Trust, Limited, at an elevation of 800 to 1,000 feet, to be known as Manik Estate. An experimental area of 10 acres was first visited and very good growth was seen. The palms, were thickly interplanted with *Tephrosia candida* as a cover crop, and for the most part were bearing good crops of fruit especially where artificial pollination had been undertaken. The nurseries are extensive and contain sufficient young palms to plant up 5,000 acres which it is proposed to open when the financial situation permits. In one field of Tea of 100 acres near to unfelled jungle, considerable damage has been caused to the bushes by Fomes and it is proposed to cut this area out eventually for oil palm culture; young palms having been interplanted between the Tea bushes. A field of 200 acres has been planted with palms as a sole crop and though only one year old from planting excellent growth is shown.

SOIL CONDITIONS.

Root system.—In the early stages of its growth the oil palm has a vertical tap-root which, however, dies leaving a surface from which a number of branching roots are produced. These roots grow and develop a mass of smaller roots which give the palm a safe anchorage in the soil. It is stated that the roots of mature palms may be traced as far as 35 feet from the base of the trunk.

Soil—Very much has been written regarding the suitability of various types of soils for oil palms but from what was seen in Sumatra and experience in this country, it is evident that it will grow and bear well in almost any soils provided they are not swampy. As is indicated above oil palms have a deep and wide root-system and favour a soil rich in humus that permits of easy root penetration and retention of moisture.

The estates visited provided a remarkable diversity of soils from the volcanic 'tufa' soil of the highlands at Siantar to the sandy soil of Poeloe Radja Estate in Asahan and the clays of Tamiang. In the latter district an area of peaty soil under this crop presents unmistakeable evidence that oil palms will not stand on such land. I was shown a series of photographs taken on an estate in the district where the majority of palms are quite prostrate, though in a healthy and growing condition. It is to be expected that similar trouble will be experienced with palms planted on the coastal peats of this country unless the peat layer is thin and supported by a firm sub-soil.

PROPAGATION.

Although there are several methods employed to accelerate germination of the seed it is usual on the majority of estates in Sumatra to sow the seeds in ordinary raised nursery beds of prepared soil containing plenty of humus to retain as much moisture as possible. With locally obtained seed germination commences at three months though old seeds or those imported from Africa will take considerably longer.

The method adopted on Tennamaram Estate, Batang Berjuntai, Selangor, was not seen in Sumatra. This consists of planting the depericarped seeds in pure sand, kept in a moist condition, supported by two horizontal 12-inch boards. When visiting this estate in April last, I was informed that good germination was obtained in seven weeks from sowing of seed. Immediately the two young leaf-sheaths appear, the seedlings are lifted and planted out about 18 inches apart on goon flat land until ready for transplanting to their permanent quarters in the field.

At Mata Pao Estate, the seeds are first sown in nursery beds of soil, containing plenty of humus, in full sun. When germination commences the seedlings are lifted and carefully planted in cocount shells cut in half. These are packed closely together and kept well watered and when large enough are again

transplanted to open land, being spaced about two feet apart, when they remain until fit for the field. It was stated that by this means a regular and quick growth was obtained at a slightly additional cost.

Mr. Mass, the Agriculturist of the General Experimental Station of the A.V.R.O.S. informed me that under experiment he had obtained the best results by fermenting the seeds between layers of cow dung and rotting leaves or pericarp refuse. The fruit are first depericarped and placed between the layers, care being taken that the temperature does not rise above 120 degrees F. It has been demonstrated by experiment that freshly gathered seeds germinate considerably quicker than old seeds.

It is essential that the propagating beds be fenced when in the vicinity of jungle or land where wild pigs are common as these animals are fond of the kernels and will cause considerable damage to the freshly sown beds in a very short time.

SELECTION OF SEED.

The Dutch planter is keenly alive to the advantages to be obtained by judicious selection of the parent trees for the production of seed for planting purposes. This is to be seen in connection with every crop cultivated in the Dutch Indies and at the present time both planter and scientist are engaged in formulating a plan of campaign with the object of selecting heavy cropping strains of oil palms producing bunches of large fruits with thick pericarp rich in oil, thin shells and heavy kernels. It has been shown clearly by experiment in Sumatra that the yields of individual palms vary considerably and it is now generally assumed that palms raised from abundant yielders will give correspondingly increased yields. It has, however, yet to be determined exactly whether any very increased production is to be obtained by this means. Should this be proved to be the case, it is evident that by means of continual selection on these lines considerable improvement in crop production may be effected.

The question of thickness of shell is of considerable importance as thin-shelled fruits are very desirable both on account of the shell being a waste product and also because of the minimum of power required for the purpose of cracking.

In general practice the planter may estimate the value of the fruit of any particular palm by cutting the fruit through transversely and observing the amount of pericarp, kernel and thickness of the shell.

NURSERY BEDS.

It is customary in Sumatra to lift the seedling palms shortly after germination and plant them in nursery beds of prepared soil where they remain until large enough to transplant or until the land is ready to receive them. The beds were seen both shaded and exposed and arguments advanced in favour of both.

In the first case it is stated that the shade preserves the moisture of the soil and results in increased growth of the palms; on the other hand the oil palm is a light-loving plant and it is thought that more healthy and stocky plants are obtained without shade. I am inclined to favour the latter plan provided it is desired to force the palms on, in which case shade would undoubtedly assist.

On Manik Estate, the young palms are frequently transplanted several times before final transplanting, as is the case with nursery stock in Europe. This is done because the soil is of a very loose character and it is desirable to cause the palms to form a root system that is compact and dense to withstand the check of planting in the field.

The nursery beds should be situated near water as the young palms are assisted during the early stages of their growth by a plentiful supply of water.

The average distance of planting in the beds is two feet squares, though the palms are frequently spaced 18 inches by 18 inches. No leaves are removed while the seedlings are in the beds but several of the lower ones may be removed during transplanting to prevent undue evaporation.

DISTANCE OF PLANTING.

The majority of oil palms in Sumatra are planted 10 by 10 meters or nine by nine meters square (32.3 feet square and 29.5 feet square respectively). The palms at Tennamaram Estate, Selangor, are spaced 28 feet 28 feet square. Perhaps the best distance may be placed at 30 feet by 30 feet triangular (equilateral) or 55 palms per acre.

TRANSPLANTING.

After the land has been marked out ready for planting the holes should be opened in advance to allow the soil to be acted upon by the weather. The holes should be dug rather deeper than necessary and a quantity of the surrounding surface soil placed at the bottom. The palms are ready for transplanting when they have about six leaves which is usually the case when they are about a year old. They may be transplanted successfully when considerably larger but increased labour costs make this prohibitive in ordinary estate practice. Planting should be done during rainy weather and when the soil is in a damp condition. Should dry weather intervene, the palms may be assisted to become established by being shaded with a few broad leaves. The oil palm stands transplanting well and with care little supplying is necessary.

TREATMENT OF THE LAND.

Considerable more care is taken in Sumatra than in the Malay Peninsula to prevent soil wash and constant care is given, from the time of opening up the land, to preserve the valuable surface soil. Immediately after planting two or three lines of the Giant Mimosa (*Mimosa invisa*) are sown between the palms.

This is a rapid growing dense leguminous plant and I was very much impressed by what I saw of its use as a wash preventative and cover plant throughout Sumatra. It is not allowed to grow too close to the young palms and when properly established it becomes necessary for a gang to go round and turn it back and beat it down with sticks. This cover prevents much surface wash but, where necessary, catchment pits are dug and the soil thrown above the pit forming in process of time a system of terraces. On other than low-lying or swampy land no open drains are ever allowed, on account of the soil lost by the running water. Their place is taken by large catchment pits which are cleaned out periodically and the soil thrown back on the land.

On low land, in addition to the main drainage system it is essential that precautions be taken to prevent surface moisture becoming stagnant and resulting in an additional growth of weeds. Where necessary a line of shallow pits should be cut between the rows of palms and the shelf of the trench bevelled for a distance of about 10 feet, the earth being mounded to the trunk of the palms. This is an expensive operation and is only necessary when the surface soil suffers from a high water table.

At Poeloe Radja Estate, in the Asahan district, where large areas of lalang land are being brought under oil palm cultivation, the Giant Mimosa is used with considerable success in killing out this weed. The method employed is to plough the land over twice with motor tractors and to establish a thick cover on the land before the lalang has a chance to recover. The land is then examined carefully once a month for signs of returning lalang which in a few months totally disappears.

It has been suggested by some writers that it is advantageous to grow catchcrops between the young palms. It is possible to grow several leguminous crops during the early stages of growth but in general the practice is to be discouraged. On one estate in this country a large area of land was planted up with sweet potatoes and the condition of the palms as compared with those clean weeded showed conclusively the deleterious effect of the sweet potatoes.

There are other cover plants likely to be of value. The Sarawak Bean (*Dolichos Hosei*) is a suitable cover on rich friable land but the Butterfly Pea (*Centrosema Plumieri*), is not as suitable on account of its habit of creeping up the trunks of the palms.

On low-lying land it is essential that a proper system of drainage be adopted as the oil palm is very impatient of stagnant moisture and will not grow on land with a high water table. The methods adopted with coconuts on such land may be applied in the case of oil palms.

No artificial manuring has as yet been resorted to in the East Indies and it seems unlikely to be necessary, at least until the palms are considerable older. Vegetable refuse, in the form

of leaves and pericarp waste may be applied to the land. Several species of *Crotalaria* are being tried on several estates in Sumatra with the idea of turning the mature plants into the soil and thereby improving the land by the addition of humus and nitrogen. So far these experiments are incomplete but it seems likely that in the case of palms in bearing much might be done to maintain their yield by the periodical ploughing into the land of suitable leguminous plants.

As a permanent cover, *Tephrosia candida*, is used on several estates and though on the one hand it produces a large amount of valuable humus in the form of dead leaves, it is almost too tall and strong growing a plant to be very suitable for this purpose. To ensure the prevention ofalang becoming established, the plants should be grown in lines between the palms to permit of supervision.

PRUNING.

The experience so far in Sumatra is somewhat conflicting, but it is now generally thought that the leaves below the growing bunches should not be removed until the fruit is almost ripe and ready for removal. If too many leaves are cut, the crop decreases and the palm is forced to form more leaves and thus grows taller than under normal conditions.

To obtain further information on the influence of pruning on production, experiments should be conducted with palms in this country.

POLLINATION.

Early in the cultivation of the oil palm in Sumatra it was found that many bunches produced no or few fruits, a fact thought to be due to the non-pollination of the female flowers. This has since been demonstrated to be the case both by experiment and general estate practice. Preliminary experiments with palms at the Experimental Plantations, Kuala Lumpur, show conclusively that artificial pollination results in a greatly increased crop of fruit. When pollination has been effective, the fruit forms over 50 per cent. of the weight of the bunch, whereas with poor pollination the percentage drops to 20 per cent. or often lower.

Dr. Fickendey of Poeloe Radja Estate, Asahan, informed me that the insect that effects pollination of the oil palm in the Cameroons is not represented in Sumatra and so far he has observed no insect to take its place in the East. Experiments conducted on the Netherlands Rubber Maatschappijs' property have convinced him that to obtain satisfactory crops it is necessary to organize a proper system of patrols to examine and pollinate artificially every female spadix that is produced.

On Mata Pao Estate, a series of experiments have been conducted by the manager under the supervision of the General Experimental Station of the A.V.R.O.S., and very striking results

have been obtained demonstrating clearly that considerably higher yields are obtained by artificial pollination. Every palm on the estate is now inspected and treated by a special gang every three days and it is found that one coolie can deal with 20 acres of palms a day, i.e., one coolie is required for every 60 acres of palms having reached the flowering stage. The palms on this estate are planted 10 meters by 10 meters square.

The subject of artificial pollination of the oil palm is too exhaustive to be dealt with fully in this report but it is hoped to publish the information available in the Agricultural Bulletin when the matter has received further attention on the Experimental Plantations here. Briefly the operation is as follows. The male or pollen bearing cones, generally born in greatest abundance during the early stages of the palms growth, are sought for and several bearing ripe pollen are cut and carried to a sheltered shed. The cones at this stage may be easily detected as the flowers emit a strong smell of anise as is the case with the female flowers during the receptive period. The male cone is placed in a glass jar or metal receptacle, specially made for the purpose, and shaken vigorously when the pollen is expelled and is collected in a bottle. Provided the pollen is kept dry in a desiccator it may be used for a month or so, as upon examination pollen so kept for 60 days gave 50 per cent. germination. The pollen for use is placed in a spraying bottle constructed on the lines of a scent spray. The female cones in a receptive state are then sprayed with the pollen and the operation recorded by marking the leaf base above with a spot of white paint. The female flowers remain in a receptive state for three days only and experiments have shown that pollination conducted the day before or after this period fail to effect fertilization. A female spadix contains several thousand flowers but it is unusual for more than 1,000 to develop into fruit in ordinary circumstances. Dr. Heusser, Botanist at the General Experimental Station of the A.V.R.O.S. records in one instance a hand-pollinated cone producing 4,800 mature fruits in one bunch. The fruits ripens in about six months from pollination.

On Poeloe Radja Estate, certain palms have been selected as desirable bearers and after fertilization with pollen from other selected palms, the cone is tied up in a waterproof paper bag to prevent cross pollination with unselected palms.

HARVESTING.

Observations have been made in Sumatra to determine the distribution of the crop over the year and it appears that there is a correlation between distribution and rainfall. Dry weather results in the production of fewer bunches.

Young palms on well-managed plantations do not present very great difficulties with regard to harvesting the crop as the bunches are readily accessible and with the aid of sharp hatchets

may easily be detached from the palms. It is essential, however, that the ripe bunches be gathered carefully and received at the factory as soon as possible, as, if the fruits be damaged or kept lying about, fermentation commences and the resulting palm oil will be inferior on account of its high acid content. This matter is of considerable importance and has been dealt with by Mr. van Heurn, Chief Chemist of the General Experimental Station of the A.V.R.O.S. at Medan, and published in the 'Communications' of that station. Mr. van Heurn contends that with efficient transport and factory methods and the rapid working of sound and fresh fruits; palm oil for edible purposes may be produced in Sumatra that will have a very decided advantage over that produced in West Africa, where the factories are dependent on fruits gathered and often brought in long distances by natives. According to Eisenstein and Rosaver, the free acid content of African oil palm may often be as high as 50 per cent. whereas with care it is now possible to produce oil in the factory with an acid content of 7 to 8 per cent. and with improved methods this should be even lowered to about one per cent.

On Poeloe Radja Estate, an extensive system of rails is being laid for the purpose of conveying the crop from the field to the factory and it is very evident that on large properties it will be necessary to lay down some such system for the rapid and economical transport of the fruit.

It is found that one coolie can collect 30 average bunches of fruit a day, or approximately 9,000 bunches a year. This is equivalent to the yield of 18 acres, i.e., 900 palms giving in a year 10 bunches each. As the palms begin to grow tall and it becomes necessary for the coolie employed in collecting the fruit to climb the palms it is obvious that the costs of collection will become considerably higher. At St. Cyr Estate where many of the palms are now over 37 years old, the coolies use tall bamboos for the purpose of ascending the palms. A number of small square spaces are cut in the bamboo into which the labourer places his toe and by this means is able to climb rapidly up into the crown of the palm. This method has a great advantage in that the coolie is able to enter the crown away from the trunk and thus avoid all the spines at the base of the leaves. After the bunches have been cut and lowered to the ground any superfluous leaves may be pruned back to the trunk; the two operations should be done at the same time in the case of old palms to economize in labour. Where a plentiful supply of suitable bamboo is not available it is a sound plan to plant up a small area for the future production of bamboo stems.

YIELDS.

Records of yields have now been taken for several years on a number of estates in Sumatra but it seems doubtful whether these represent what may be expected in view of the heavier yields that systematic artificial pollination is likely to bring about.

Whether such yields will be maintained and whether heavy cropping will have a harmful effect on the palms, especially in the case of young plantations, is a matter for further enquiry.

During a visit to Poeloe Radja Estate, where there are now 3,000 acres of oil palm in bearing and further land being planted up, I had the opportunity of discussing with Dr. Fickendey the question of yields as obtained on the estate. He considers the average yields to be as follows:

Fourth year from planting ... 45 lbs. of fruit per palm per annum.

Maximum yield ... 175 lbs. of fruit per palm per annum.

The yields collected from the two sets of 20 palms on this estate during 1918 and 1919 and published by Dr. Rutgers give the following average yield per palm per annum. The palms are planted 29.5 feet by 29.5 feet square. The small fruits in the bunches were not weighed so the figures are somewhat conservative.

Age of palms.	Total bunches.	Total weight fruit.
6-7 years ...	12.8 ...	50 lbs.

Yields of 40 numbered palms on Mata Pao Estate, taken during 1919, six years from planting, give the under-mentioned yields per palm per annum. The palms are planted 32 feet by 32 feet square.

Age of palms.	Total bunches.	Total weight fruit.
6 years ...	9.3 ...	45 lbs.

Based on the recorded yields obtained in Sumatra during 1918 and 1919 from both estate and ornamental palms, Dr. Rutgers has published the following estimated yields.

ESTIMATED YIELD PER PALM PER ANNUM IN LBS.

Year.	Number of bunches.	Weight per bunch.	Total weight of bunches.	Total weight of fruit.
5th to 10th	12	13	158	53
11th to 30th	10	33	330	165
31st to 50th	3	44	132	66

After consulting several authorities on oil palms and analysing carefully the yields obtained from individual palms on several estates in Sumatra, I have compiled the following estimate of average yields in that country for palms planted about 55 to the acre.

ESTIMATE OF AVERAGE YIELD PER ACRE.

Year in bearing	Cleaned fruit per acre per annum.				
1	...	...	...	...	1.1 tons.
2	...	...	...	...	1.2 "
3	...	...	...	...	1.4 "
4	...	...	...	...	1.5 "
5	...	...	...	...	1.7 "
6	...	...	...	...	2.1 "
7	...	...	...	...	2.5 "
8	...	...	...	...	3.3 "
9	...	...	...	...	3.5 "
10	...	...	...	...	4.0 "

Beyond this age it is not possible to estimate with any degree of accuracy as the only yields that have been recorded are those from ornamental palms which have not always received the treatment that is now adopted on plantations. After this stage the cost of collecting the bunches will be greater and will have to be taken into consideration.

THE PERCENTAGE OF PERICARP AND KERNELS IN THE FRUITS.

Analyses of the fruits from a number of estates in Sumatra give the following figures.

Pericarp	...	...	62 per cent. of the fruits.
Kernels	...	...	8 " "

As a basis for further calculations it is safe to place the former figure as 60 per cent. pericarp. With regard to the kernels it appears unlikely that this figure will be actually obtained in estate practice on account of defective nut-cracking machinery. With improved designs, however, this percentage should be obtained, though for the present is a matter of little importance as the nuts are exported and cracked in Europe.

THE PERCENTAGE OF OIL IN THE PERICARP AND KERNELS.

According to the analyses conducted by Mr. van Heurn, Chief Chemist of the General Experimental Station of the A.V.R.O.S., the oil content of the Deli type of oil palms average as follows:

Pericarp	...	...	...	55 per cent. oil
Kernels	...	...	...	50 " "

ESTIMATED COMPARISON BETWEEN PRODUCTION OF COPRA AND PERICARP AND KERNELS OF OIL PALMS.

Copra.

50 nuts per palm per annum @ 250 nuts per picul of copra.
 $= \frac{100}{8} \text{ lbs.} \times \frac{1}{8} = 26.6 \text{ lbs. copra per palm per annum.}$

Oil Palm Pericarp and Kernels.

100 lbs. of cleaned fruit per palm per annum yielding 60 per cent. of kernels.

100 lbs. of cleaned fruit per palm per annum yielding 8 per cent. of kernels.

$= \frac{100}{1} \text{ lbs.} \times \frac{8}{100} = 8 \text{ lbs. palm kernels per palm per annum.}$

MACHINERY AND FACTORIES.

The machines used in Sumatra in the preparation of palm oil and nut-cracking are at present far from satisfactory. Progress in the direction of efficient oil palm machinery is remarkably slow mainly on account of the apparent inability of the manufactures to recognize what is required for the extraction of palm oil as against other oils in general.

During my visit to the General Experimental Station of the A.V.R.O.S., at Medan, Mr. van Heurn, the Chief Chemist, of the station kindly showed me the experimental plant installed there for dealing with oil palm fruits. The machinery was mainly supplied by Haake of Berlin and, though generally in advance of that met with on estates, there are a number of parts that require considerable improvement before they may be considered satisfactory.

Power.—A Kromhart Oil Engine, 12 h.p., made by D. Goedkoop, Jn. Amsterdam.

Heating Tank.—An ordinary steam tank, 15 inches deep by 12 inches diameter, standing a pressure of $2\frac{1}{2}$ kilograms per square centimeter. The steam is obtained from a small boiler outside the building giving a pressure of 2 atmospheres at 120°C . The Heating Machine supplied by Haake is of little use as the heating chamber is too short resulting in the fruits being insufficiently heated.

Depericarping Machine.—This machine is capable of dealing with 150 kilograms of fruits per hour. It is however unsatisfactory on account of the knives being set in such a position that they become rapidly blunt and chipped by coming into contact with the nuts.

Oil Press.—The ordinary cage presses are fairly satisfactory. The type installed can treat 36 kilograms of whole fruit in an hour of 4 pressings of 9 kilograms a time.

Nut Crackers.—The machine is capable of cracking 150 kilograms of nuts in 16 minutes of which 65 per cent. of the kernels are undamaged and the remainder spoilt. About 10 per cent. of the nuts usually remain uncracked depending on the thickness of the type of fruit being treated.

At Mata Pao Estate, I inspected the factory which is small and contains machinery that is not very satisfactory. The fruit upon being received at the factory is separated from the bunches by hand labour and heated and crushed in iron pans over fires. The fruit, after heating, is pressed in hand cage presses, of which there are four. After the oil has been expressed the pulp is thrown away without the nuts being extracted. To illustrate the low returns of oil obtained by this method the actual returns from the factory for the month are appended.

Returns for the month of April, 1921.

94,894 kilograms cleaned fruit.

15,570 " " oil.

i.e., 16.4 per cent. oil from the fruits,

As already stated the machinery actually working in Sumatra is so unsatisfactory that there is no point in making any recommendations based on what was seen there. Mr. van Heurn kindly placed at my disposal an English translation of a paper recently published by him as No. 10 of the 'Communications of the General Experimental Station of the A.V.R.O.S. at Medan', under the heading 'Proposals for the arrangement of Factories for preparing Palm Oil.' This paper contains proposals for the design of a factory for dealing with a plantation of 5,000 acres with illustrations of modern machinery and suggestions for the factory and hanging shed, and will be the subject of a further communication in this bulletin.

SHIPMENT OF OIL PALM PRODUCTS TO MARKET.

The pericarp oil is shipped to Europe in American barrels which, however, do not appear to be very satisfactory on account of their liability to burst open and leak. The barrels are white-washed to show early signs of leakage. The whole matter will require careful consideration to ensure improved methods of handling. Kernels are shipped in sacks, after having been thoroughly dried and appear to travel without damage. It is necessary to use care in shipping the kernels, as, if packed too solidly, there is a danger of fire in the hold of the ship.

PESTS AND DISEASES.

As has been the case with other major plantation crops of the East, when planting on a large scale has been undertaken, pests and diseases make their appearance and increase in importance as the area under cultivation extends. Hitherto the oil palm has been comparatively free from serious attacks from pests and diseases but at the present time in Sumatra several pests require to be guarded against.

Rats and squirrels are the cause of considerable damage to the ripe fruit on many estates and in a number of cases the presence of the former may be traced from the time that a crop of paddy or other foodstuff was grown on the land during the early stages of the palms' growth. It is inadvisable to grow any such crops in the palm area and a careful watch should always be kept for the appearance of these animals.

The position with regard to insect pests is almost the same as in the case of the coconut palm and the precautions to be taken to prevent the rapid increase of these insects also apply. The most serious damage caused to oil palms on a large scale was seen on an estate in the Asahan district, where a large block was badly attacked by bag caterpillars (*Psychidae* sp.) resulting in the majority of the leaves of the palms dying. Not only were the palms in a very sick condition and unproductive but there also appeared the possibility of considerable damage should the leaves catch fire. The female moth produces 3,000 or so young larvae which rapidly become distributed through various agencies to the surrounding palms. The pupa is frequently parasitised by a

Tachinid fly. It is considered that the most effective means of destroying this moth is to spray the palms with a Paris green solution (one to 1,000 parts water) by means of a power spray. This operation is likely to be expensive, especially when the palms are tall, so it is evident that there is much to be gained by periodical inspection of the palms and dealing with any such pest immediately it appears.

The coconut beetle (*Oryctes rhinoceros*) is becoming a pest of some importance. The adult beetle enters through the petiole of a leaf and bores through the trunk sometimes damaging the terminal bud, causing the death of the palm. It is essential to have all rubbish, such as trash from the trunk and pruned leaves, burnt or spread over the land in a thin layer to prevent the beetles breeding.

The red weevil (*Rhynchophorus ferrugineus*) is also becoming a troublesome pest in Sumatra and was recorded¹ as attacking oil palms on the Experimental Plantations, Kuala Lumpur during May of last year. In this instance the adult beetle was seen to lay its egg in the recently out surface of the petiole and it is therefore importance to see that such surfaces are tarred over or otherwise protected. The larva bores into the centre of the palm and causes much damage, sometimes penetrating the terminal bud, resulting in the death of the palm. A watch should be kept for this pest and care taken that the palms are not wounded and all exposed parts tarred over.

Several minor pests have been recorded but so far only as isolated cases. On one estate, the larva of a moth (*Melisso-blaptus rufavenalis*), has been found tunnelling in nearly ripe oil palm fruits.

No fungoid diseases have been the cause of any serious trouble but in view of reports² of the presence of several in West Africa, careful watch is being made for any such outbreak in Sumatra.

¹ Agricultural Bulletin, F.M.S., Vol. VIII, No. 4, p. 249.

² See Agricultural Bulletin, F.M.S., Vol., VIII, No. 4, p. 244.

A NEW FUEL OIL.

TESTS WITH PALM OIL.

CONSIDERABLE attention is being paid at present to the problem of fuel supplies. The world's supplies at present consist almost entirely of coal and petroleum.

One of the great problems of the day is to discover a new source of fuel for power purposes and attention has been directed especially to the utilization of water power and the manufacture of alcohol.

Alcohol can be produced from vegetable matter of all kinds although not necessarily economically, but hitherto its production has involved the use of valuable food products, except in the case of certain products such as molasses, saw dust, rice-straw, etc.

Another possible source of fuel of vegetable origin has recently been investigated, namely Palm oil, one of the products of the Oil Palm (*Elaeis guineensis*). Tests were commenced with this oil in 1914 and resumed after the war by a Belgian Company, the Omnium African, which has since amalgamated with another Belgian Company, the Belgoleum, and changed its name to La Compagnie Generale du Congo. The capital of the Company is 20 million francs.

A large English firm is stated to be also interested and has carried out tests in the Congo. Both companies are largely interested in the palm oil industry.

Experiments in Belgium.—The Belgian tests referred to above were carried out in Brussels with a Swedish engine, the "Drott," a two cycle semi-Diesel engine of 8-10 h.p. at 500 revolutions per minute. The engine is of simple design and strongly constructed. The only special feature required, in order to adapt it to palm oil, was a particular type of feed tank for keeping the oil in a liquid condition. Normal palm oil has a melting point of 37°C. and is of a viscous or semi-solid consistency at ordinary temperature and therefore, for use in an engine, must be kept heated and liquified. It was found that low grade unrefined palm oil, having a high percentage of free fatty acids, could be used satisfactorily. The fatty acids were almost completely burnt and there was no corrosion. This is important, since the refining of the oil is troublesome and costly. High grade palm oil is probably too valuable for other purposes to be employed as a fuel oil. Such low grade oils if used as fuel would probably however have to compete with the soap industry.

In order to keep the oil liquid, the feed tank, consisting of a series of compartments, separated by fine-mesh metallic screening, is heated by the cooling water of the cylinder, this water being heated to about 70°C.

The waste exhaust gases also help to heat the oil and evaporate any moisture in the oil; complete liquifaction is further ensured by placing a small petrol vapour lamp under the tank. The object of the screened compartments is to effect filtration of the oil (*N.B.*—It might be preferable to filter the oil beforehand). The "Drott" engine is designed with certain unusual features which the makers, during 20 years experience, favour, although these features are said to be contrary to general practice in Great Britain and America. This does not however affect the main problem as to the suitability of the palm oil as a fuel, for the question arises in connection with other fuels employed in this engine.

Up to the present it has been found necessary to start the engine with petrol and to finish the run with petrol, so that no palm oil is left in any part of the engine while at rest, as the residual oil would congeal and clog the engine parts: a small petrol tank is therefore provided alongside the palm oil tank. The tests so far are said to be satisfactory and are being continued.

Other vegetable oils have occasionally been tried but with little success. About 20 years ago, according to a French engineer, attempts were made to run an "Otto" Engine (one of the earliest internal combustion engines) with Castor oil, but this caused considerable corrosion and formation of acetic acid. Ground nut oil has also been tried as a fuel oil with little result and it is also too expensive and more valuable as an edible oil. (Abstract from "The Chemical Age" Volume IV, No. 102, 28th May, 1921.)

B. J. E.

THE VEGETATIVE REPRODUCTION OF SELECTED STOCK OF HEVEA.

By J. N. MILSUM.

IT is now generally understood that there is considerable variation in the yields of individual rubber trees and it has been found that by means of budding, trees may be propagated with all the visible characters of the parent tree. It is as yet a moot point whether this applies in the case of yield of latex, but it appears possible and preliminary investigations in Java are said to confirm this supposition.

The writer having visited recently the east coast of Sumatra, it appears to be not without interest to record what is being done in this connection, in that country, supplemented with observations gathered from experiments in propagating Hevea at the Experimental Plantations, Kuala Lumpur. It is to be appreciated that as far as the actual practice of budding is concerned, the work is now on an established basis and employed on a number of estates, that are planting rubber. As to whether these areas, when in tapping, will give the yields that are anticipated is a matter for the future.

PRELIMINARY INVESTIGATIONS TO DETERMINE HIGH YIELDING TREES.

This matter is more complex than is often supposed as so many factors may influence the yield of latex. In the first instance it is uncertain to what extent latex production is a hereditary character. Secondly, whether the yield of latex from any individual tree is constant and not variable according to age and external conditions. A further consideration is what relation may exist between the root of the stock seedling and the eventual yield of the budded tree. It is evident that more research is necessary to enable these questions to be answered with precision.

Very considerable efforts are being made in the Dutch East Indies to ascertain which are consistent high yielding trees for the purpose of providing stock for future planting. In this connection the patient work of the Cinchona planters in Java may be mentioned, where by a long series of selections, strains of Cinchona trees have been obtained and reproduced vegetatively with a considerably increased percentage of alkaloid in the bark. No analogy can be made between yield of quinine and latex production, as the means of extracting the product are so widely separated but it does seem possible that the methods employed in Java with Cinchona attended by such marked success may be applicable in the case of Hevea.

To collect data for furnishing evidence as to the heaviest yielders on an estate, the following method is employed. A special gang of coolies follow the tappers and measure the latex

from each tree once a month. Glass tubes graduated in six divisions and marked with a simple sign to indicate six classes of yielders, are issued to the gang. The sign representing the volume of latex is then marked on the tree with a tapping knife. A vertical series of twelve such signs thus indicates the yields for twelve monthly measurements. Six measurements are said to be sufficient to indicate the lowest yielders but the longer the yields are taken the more reliable is the information obtained. It must be borne in mind that disease stimulates the flow of latex, so it is important that sufficient time elapses to ascertain whether disease is present or not. The trees finally selected are marked with a band of paint.

More precise information may be obtained by marking out the trees that have been found to be consistently the best yielders and after coagulating the latex on at least two occasions a month, recording the average dry weight over a period of one or more years.

Let us assume that a number of trees have been selected as the heaviest yielders on any particular plantation. These trees will provide the material for future planting and it is then necessary to raise nurseries of seedlings as stocks for budding from the selected trees.

SEED FOR STOCK PLANTS.

In selecting the seed for the stock seedlings the principle of improvement should be borne in mind and only seed from healthy and high yielding trees be collected. It should be appreciated that seed from such trees are likely to show considerable variability on account of their unknown parentage on the male side. Heusser¹ has shown, after many experiments with artificial pollination, that *Hevea* is 'adapted for cross pollination and is not absolutely self-sterile, but usually 'selfing' is unsuccessful. Even should it be possible to ensure pollination of the female flower by pollen from male flowers of the same tree, the offspring will still show variability account of impurity of strain brought about by possible cross pollination in the previous generation.

NURSERIES.

The nursery beds should be laid out from East to West and be about 4 feet wide. The seeds are planted in rows $1\frac{1}{2}$ feet apart either way, thus allowing plenty of space to work in during budding operations.

TIME FOR BUDDING.

Seedlings are considered to be a suitable age for budding when six to nine months old, according to growth. Seeds sown during September produce stumps ready to be budded the following May. Generally the period from the termination of the wintering period to the autumn rains is the season for budding. Further experience is necessary to determine the best months for budding operations in this country.

¹ 'Archief voor de Rubbercultuur.' December, 1919, p. 455.

PREPARATION OF THE MATERIAL.

A good material for the binding cloth is ordinary unbleached cotton cloth which is readily procurable from native importers. The cloth is obtainable 34 inches wide and may be cut into two strips of 16 inches wide and is then ready for waxing. Other sizes are procurable but it is most economical to have a cloth of sufficient width to strip into two. After waxing, strips of material are cut off measuring 16 inches by one inch. One yard of cloth provides material for binding up 70 stocks. Should binding cloth be required for older stumps, then the strips will have to be correspondingly larger.

Several mixtures have been recommended for waxing the cloth but when tested at the Department of Agriculture, were found unsuitable for general use. The following ingredients make a good wax and so far appear to be the most suitable, though other cheaper grades are satisfactory.

Fifty per cent. Petroleum Jelly (Paraffinum molle flav).

Fifty per cent. White Paraffin Wax (Melting point 125/30 degrees F).

These materials are obtainable in quantity from local firms at the following prices.—Paraffinum molle flav, 70 cents a lb., White Paraffin Wax, 15 cents a lb. (\$19.50 a picul). These two ingredients are melted down in a kerosine tin over a fire, and after a thorough mixing the solution is ready for waxing the cloth and is removed from the fire. A convenient size for the cloth is 16 inches wide by 10 yards long. This, when rolled up, is immersed in the liquid wax and kept moving for 10 to 15 minutes to ensure thorough saturation. The cloth is then unrolled in the solution and hung over a frame in a cool shed to dry, when it is rolled up and ready for cutting into strips for use. One pound of the mixture is sufficient to wax one roll of cloth. The actual costs of this waxed cloth is as follows:

	\$	cts.
Strip of cloth, 16 inches by 10 yards ...	2	00
Half lb. Paraffinum molle flav at 70 cents per lb.	0	35
Half lb. White Paraffin Wax at 15 cents per lb.	0	08
	2	43

A roll of cloth is sufficient to make 350 binding strips, so that the cost per strip works out at approximately seven-tenths of a cent.

It is essential to have a good sharp knife. The large types of budding knives as used in Europe are suitable, though other patterns are also satisfactory. A hone should be kept handy and care taken that the edge of the knife is keen during use.

BUDDING.

As previously indicated, it is considered that the most satisfactory method of reproducing *Hevea* vegetatively is by budding on the young seedling trees that are still in the nursery beds. The details of this operation will, therefore, be described fully and brief reference made only to other possible forms of asexual reproduction. To obtain an idea of the method recommended which is an adaptation of the Folkert method, the sketch accompanying this paper should be consulted.

A rectangular tongue of bark, from $1\frac{1}{2}$ - $2\frac{1}{2}$ inches long by about $\frac{1}{3}$ the circumference of the stem is lifted and a bud of approximately the same size from a selected tree is inserted beneath. This is then bound up with the waxed cloth and rubbed over gently with the hands to cause the wax to become softened and adhere to the stem.

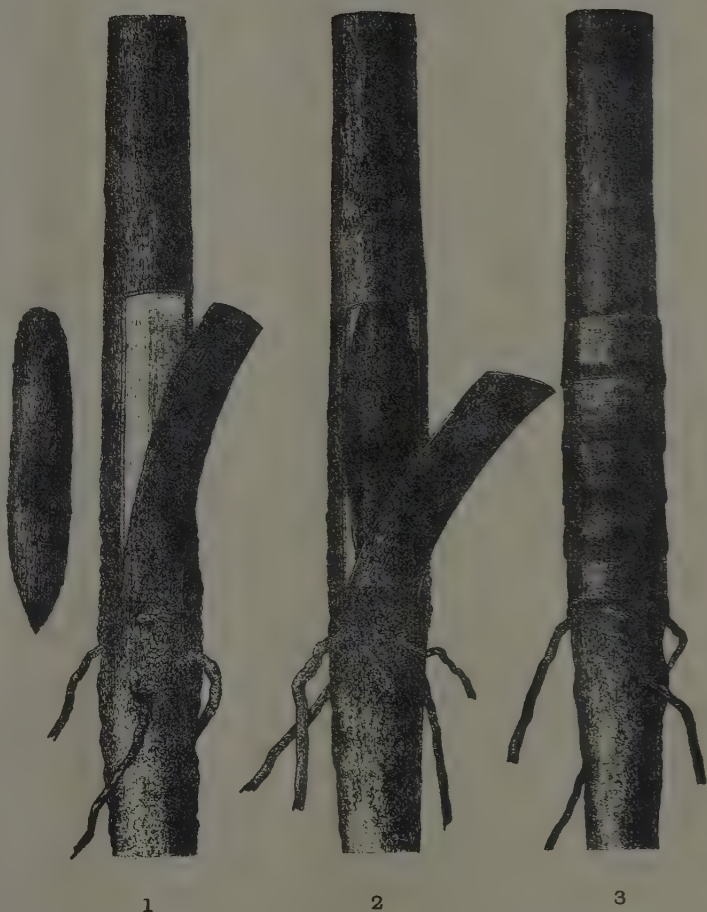
It is important that the bud be attached to the stock as near to the ground as possible and that during the operation, speed and cleanliness be ensured.

To prevent the latex forming a film over the exposed cambium and thus preventing the proper union of the stock and scion, it is necessary to outline the incisions a short time before the bud is actually removed and inserted beneath the tongue of bark of the stock. About 25 of these incisions may be made before the workman returns to prize up the bark and insert the bud. The bud is situated above the leaf scar. It should be cut from the branch with a portion of the bark above and below it. Any wood adhering to the bud should be removed.

Only mature bark should be used as scions and it should peel easily from the branches of the parent tree. The branches should be removed from the tree early in the morning and be cut up into short lengths and stored in kerosine tins and covered with damp sacking to prevent evaporation.

After two weeks from the time of budding the binding may be removed for the purpose of testing whether the bud has 'taken' or not. To make this test the bark of the bud should be slightly scratched with a knife. Success is indicated by the tissue beneath the cork layer showing green; when black or brown the bud is dead. Failures may have another bud inserted on the other side of the stock and be treated as before.

Those stocks on which the buds have 'taken' are left for a week or more when they are cut back to within about six inches of the living bud. Should the stock be not cut back the bud will remain dormant and refuse to grow. Care must be taken that suckers do not sprout from the stock; should they appear they must be removed early to throw all the vigour of the stock into the bud.



F. B. LaMotte Morris

BUDDING OF HEVEA

1. Seedling and bud ready to be inserted
2. Bud inserted
3. Bound up with waxed cloth

COSTS INCURRED IN BUDDING STUMPS.

Until the coolies engaged in budding have had considerable practice, it is unlikely that they will exceed budding 200 stocks during an eighth hour day. A skilled workman will be able to do 250 in a day and possibly more. The costs in connection with the operation work out approximately as follows:

Two hundred budded stumps less 10 per cent. failures=180 stumps from a coolie earning 45 cents per day	.25 of a cent
Cost of waxing cloth	.70 ,,
	.95 ,,

or \$10 per 1,000 stumps.

There are certain additional charges that must be taken into consideration, but it is a matter of some difficulty to estimate for such as selection of wood for budding, collection and transport to the nurseries, unbinding the waxed cloth, cutting back the stock after the bud has 'taken,' and finally the additional care of raising the seedlings and transporting the stump to the clearing.

It is usual in Sumatra to pay the coolies employed in budding a small sum according to results in addition to their ordinary wages. In all probability, Chinese will make the best workmen in this country and though they will require a higher wage, will turn out a greater number of budded stumps. It is advisable to have a small nursery of stumps set aside for the purpose of training fresh coolies.

SUBSEQUENT TREATMENT.

It is as yet a matter of some uncertainty as to the best system to be adopted to establish the stumps in the field after the buds have been grafted on successfully. The two principal methods are:

- (1) Transplanting the stumps to the field while the buds are still in a dormant condition.
- (2) Allowing the buds to develop in the nursery and planting the stumps in the clearing with several inches of growth from the attached bud.

In the first instance it is claimed that the operation of transplanting results in the buds sprouting earlier and the stumps becoming established sooner in the field. On the other hand it would appear that it is advantage to have the stumps properly developed prior to planting to ensure a regular stand of sound trees. Further experiments are necessary before definite recommendations can be made, but it is hoped that this information will be available in the near future.

BUDDING STUMPS IN THE FIELD

This system is not to be recommended on account of the difficulty in securing a regular stand of budded trees. A less number of 'takes' are obtained when the stumps are budded in the open field on account of exposure to the sun and air. Similar conditions to that obtaining in the nursery may be secured by planting two or three tapioca cuttings around each stump, but this means a considerably added expense. The cost of budding is increased because of the greater area the coolie has to cover.

OTHER FORMS OF BUDDING.

Patch Budding.—A rectangular patch of bark about two inches by half an inch is removed from the base of the stock and a similar sized patch from the selected tree is inserted. The subsequent operations are as already described for the Folkert method. It has been stated that on anatomical grounds, patch budding has certain advantages over other methods, the principal of which being quicker union of patch and stock. It is possible to have special knives made that work to a scale and ensure the bud patch being exactly the same size as the piece of bark removed from the stock.

GRAFTING.

Mass records¹ success with grafting ranging from 40 per cent. successes in the case of cleft-grafting, to 55 per cent. with side-grafting, up to 75 per cent. with crown-grafting. It is however, considered to be too troublesome an operation to be of practical value and in view of the success with budding, unnecessary.

PROPAGATION BY CUTTINGS.

In 1919, the writer carried out a series of experiments for the purpose of ascertaining the possibilities of propagating Hevea by cuttings. Wood in various stages of development was used but in no case was more than five per cent. of 'takes' recorded. The experiments proved conclusively that under ordinary conditions, propagation by cuttings is unsatisfactory.

Burkill² records that out of 1,489, 1-2 inch stakes placed in the ground during January and February, 1917, only 18 or 1.21 per cent., took root and produced leaves. Experiments with cuttings from young twigs were without success.

Similar results were obtained by Mass³ in Sumatra though he states that better results were obtained by ringing the stem prior to severing it from the parent tree. Further, he recommends placing the cuttings deep in the soil and waxing or tarring over the cut surfaces.

¹ "Archief voor de Rubbercultuur." August, 1921, p. 279.

² Garden's Bulletin, S S., Vol. II, p. 54.

³ "Archief voor de Rubbercultuur." August, 1919, p. 286.

Experiments at the Experimental Plantations here, have shown that often good success may be obtained by marcottage, especially in the case of young trees that are marcotted near the ground level. The operation consists of ringing the stem of the young tree as near the ground as possible and placing an earthenware pipe round the stem. The receptacle is then filled with sandy soil and kept in a moist condition. Roots are produced in from two to three months the stem may be severed and the tree removed a month or so later. Several lateral shoots are produced from the stump, which in turn may also be rooted.

It is more difficult matter to marcot the upper branches of an older tree, mainly on account of keeping the soil surrounding the ring in a moist condition. An experiment is being conducted to ascertain what degree of success may be obtained by this method. A platform is constructed in the branches of the tree and the soil surrounding the marcot kept moist by daily watering, using a small tin above each ball of soil as a supply.

Arens has recently published a paper¹ in which accounts are given of the behaviour of several areas planted with 'gootee' layerings of Hevea. In the majority of cases the results were good, so much so that one estate is adopting this method for future planting. On this estate, the trees from layers reached the tapable age six months earlier than was the case with seedlings and gave a greater yield, presumably on account of the layers having been taken from selected tress. On one estate, with heavy clay soil, many layered trees failed to grow upright and were difficult to tap on account of the leaning position of the trees. Dr. Arens concludes that layers are satisfactory on ordinary soils that are not too wet, provided that the layers have a good root system before planting.

¹ "Archief voor de Rubbercultuur," July, 1921, p. 382.

REVIEW.

De Klappertor (Black or Rhinoceros beetle) *Oryctes rhinoceros*, Linn.

Mededeelingen van het Instituut voor Plantenziekten, No. 41 door S. Leefmans.

An exhaustive account of the habits and control of the Black or Rhinoceros Beetle—*Oryctes rhinoceros*—in Java and the West Coast of Sumatra is contained in this Bulletin.

The work is a valuable addition to the literature of this insect and contains such useful information that a résumé of the "Summary in English" of the principal conclusions is thought to be of interest to coconut planters in Malaya.

It may be mentioned that the Rhinoceros beetle has been under observation in Kuala Lumpur for some months, and the life history figures so far obtained appear similar to the author's.

The author of Bulletin No. 41 states that "the lifetime for lowland climate is now sufficiently fixed, and runs thus:

egg stage	11- 13 days
larval stage... ..	63-126 ..
inactive stage of the beetle in	
cocoon	14- 28 ..
total	<u>3½- 6½ months."</u>

At Kuala Lumpur, the length of time for the incubation of the eggs varies from 10-18 days, and for the pupal stage slightly longer than 19-27 days.

The reviewer confirms the author's statement "after emerging from the pupa, the beetle does not immediately leave the cocoon but remains inactive in the soil" but in Malaya there is also an inactive larval stage in the cocoon prior to the grub changing to pupa.

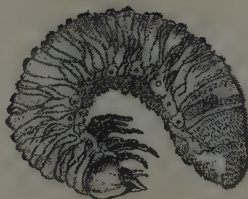
"The following substrata are fit for breeding places; they are mentioned in order of decreasing importance in the Dutch East Indies:

1. Communal refuse heaps of villages and cities;
2. Nipa-rubbish;
3. Dying and dead (erect or fallen) trunks of coconut and other palms;
4. Vegetable rubbish (coffee and cocoa husks, leaves and fruit peels, etc.);
5. Decayed dung (of cows, buffaloes and horses);
6. Rubbish of sugarcane mills;
7. Rubbish of ricehusking-mills."

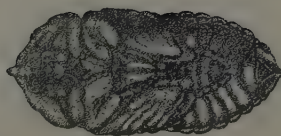
RHINOCEROS BEETLE



1



2



3



4

To this list should be added the bark of the *gelam* or *kayu puteh* (*Melaleuca leucadendron*, Linn) which serves as a favourable breeding ground for this insect in parts of Malaya.

The communal refuse heaps of villages are undoubtedly the worst breeding grounds for *Oryctes*; on one occasion in about one cubic metre of such a heap 49 grubs of the black beetle were counted.

"Experiments and observations have shown, that the holes made by the beetles only have a fatal effect on the tree under certain unfavourable circumstances, e.g., in case water can run into the hole and the palm weevil is attracted by the process of decay."

"Besides the coconut many other palms are attacked by *Oryctes*-beetles. The present author has observed damage to *Corypha gebanga*, *Livistona spec.*, *Latania spec.*, *Sabal spec.*, *Metroxylon sagu*, *Pinanga spec.*, and *Nipa fruticans*. Agave plants and oil palms are also attacked by the beetle."

"Experiments and observations showed that the beetles fly principally between 6-7 in the evening."

"As regards the means of spreading of the beetles many probably important facts were obtained."

"10. By counting the healthy, the damaged and the dead coconuts around big breeding places at Padang and Priaman."

"20. By experiments at Buitenzorg, which strongly support the supposition that the beetles do not fly far from their breeding places. Refuse-heaps, situated far from coconuts or other feeding-plants are not visited by the beetles; they visit only refuse-heaps which are in the close vicinity of their feeding-plants. This fact simplifies the fight against the insect and destroying of breeding places is only necessary in the close vicinity of coconut trees (not farther away than one k.m.)."

It is a fact that generally speaking when coconut palms are damaged by *Oryctes*, they are not far removed from and the most injured trees are nearest to the breeding grounds. When the Chief Agricultural Inspector and the reviewer were making field observations concerning this insect some damaged coconut palms near Malacca were in evidence but it was impossible to find any breeding ground. After considerable search and disappointment it was ascertained that a rubbish heap used to exist in the vicinity of the attacked palms.

The reviewer has been informed of one case where though careful examination of an area of decayed coconuts was made, no breeding ground could be found. The accuracy of this statement there is no reason to doubt.

"The maximum length of life in captivity of the beetle is 4-4½ months. The females started egg-laying after 20 to 62 days after emergence from cocoon."

"The fertility of the females is greater than was formerly believed. In place of the 25 eggs formerly believed to be normal, as many as 71 eggs have been obtained from a single female."

"II.—REMEDIAL MEASURES.

"The remedial measures in use up till now are :

"A.—against the larvae :

"1. Destroying the breeding places (in many places in the English and Dutch colonies this measure is compulsory by law);"

"2. Trapping the larvae in refuse-heaps, which are regularly controlled. Friedrichs tried to poison the trap-heaps but did not use the right poisons and Jepson advised to treat the heaps with carbon bisulphid;"

"B.—against the beetles :

"1. Catching or killing the beetles in their holes by means of a piece of telegraph wire (and filling the holes with ashes, sand-salt mixture or urine);"

"2. Trapping the beetles with lights;

"3. Trapping the beetles with fermenting juices."

"The present investigations were principally directed to obtain practical remedial measures for the native plantations. Several of the methods quoted are however not fit to be handled by the average native. The only means to be advised to the natives, seem to be the preventive measures."

".....many of the preventive measures against this pest are incomplete and either practically impossible or insufficient. Consequently it was necessary to find :"

"1. a more efficient method than the so called "burning" of vegetable refuse in order to prevent *Oryctes* breeding therein;"

"2. better and more practical methods to prevent *Oryctes* grubs breeding in palm stubs and trunks."

"We mentioned already as one of the instructions in the ordinances viz., the burying of tree trunks at least three feet deep. This instruction suggests strongly, that the investigator or agriculturist who gives this prescription (I could not trace who is the intellectual author) did not know how deep the trunks must be buried and prescribed burying at three feet depth, because he supposed this to be deep enough to make sure that the beetles should not trace the hidden breeding places."

The reviewer a few months ago had the privilege of conversing with the "intellectual author" in Malaya who informed him that burying tree trunks at least three feet deep was largely to prevent any grubs which might be in coconut logs decayed before burial from emerging as adults.

The author will fully appreciate this statement if he will take into consideration that in Malaya pupa have been found at a depth of over one metre below the surface and that the adult possesses great powers of movement through soil.

In this connection reference should be made to Federated Malay States Enactment, No. 13 of 1912, Section 15, No. II, which was embodied directly from the Coconut Trees Preservation Enactment, 1898, and states "It shall be the duty of the owner or person in charge of every coconut tree which is dead or is attacked beyond recovery by the rhinoceros beetle or the red beetle forthwith to uproot such tree and either to consume it with fire or to bury it in the ground at a depth of not less than three feet so that the beetle and all eggs and larvae thereof may be totally destroyed and that the tree may not serve as a breeding place for rhinoceros beetles or red beetles."

The author will readily see from the above that in the mind of the composer of this provision of the original Enactment was the fact that beetles, grubs, and eggs might be in the decayed wood, and that it was not framed merely to prevent the beetle laying eggs in the wood.

"As I could not find any evidence in literature that experiments have ever been made to prove that a cover of earth of three feet deep is really sufficient, it was necessary to investigate how thick a top cover of sand or soil must be, to prevent the beetles from perceiving a breeding place under the not attractive topcover (dressing). The experiments were conducted at Padang in the following way. Pits were made measuring 2 M.² in surface and half M. deep. The pits were filled with vegetable rubbish, not yet infected with *Oryctes* beetles, grubs or egg. The pits thus filled were alternately covered with sand, in such a way one pit *not covered* always was placed *alongside* one pit *covered* with a layer of sand. The not covered pits were the controls."

"In this way 77 experiments in different places were conducted with a sand topdressing varying between half M. depth and 10 cm. (four inches) depth. The result was, that *not one Rhinoceros beetle, egg or grub was ever found in the vegetable rubbish under the sandlayer*. In the 71 open control pits however were found: 222 eggs, 5,713 grubs, and 78 beetles, totalling 6,013. These results are so striking, that there is no doubt, *that even a thin layer of sand prevents the beetles from discerning the attractive breeding place hidden in this simple way.*"

"By the aid of the Common-Council of Padang the present author has been able to control the results of the pit experiments mentioned, by a practical experiment on a large scale. A piece of ground near the coast in area 25 are¹ was covered with a layer of vegetable refuse (collected daily in town and in the native market) this was always within a fortnight covered with a layer of sand from 2-7 inches. After 4½ months 23 pits were made, in order to examine the buried rubbish for Rhinoceros beetles and grubs. *Nothing* was found however even not in rubbish on which only a few inches of sand had remained."

¹ 1 Are = 100 M².

"The practical results are :

"*First*—that in order to prevent Rhinoceros beetles from breeding in vegetable rubbish it is sufficient to cover it with a layer of eight inches sand (or other non-humous soils);"

"*Second*—that the communal rubbish—in case it cannot be burned to ashes—may be used to dress (and improve) marshy lands in the vicinity of towns, *provided its being covered with the layer as mentioned before.*"

"As "coconutlogs" are dangerous breeding places too and the logs often are used for bridges and other purposes experiments were taken to conserve the logs by chemical and mechanical means. Coal tar, Kerosene, Carbolineum (creosote) and Swedish tar were used (after removing the cortex) furthermore the topheads were coated with pieces of kerosene tins. Though very old solid coconut trees were used, the result was after nine months that even logs, treated with disinfectants as mentioned before, showed at the ends of the logs a heart rot of 11-37 c. and in the controls of 24-65 c. in case they were used for a foot-bridge in the open air. A heart rot of 18-48 c., of the prepared logs and of 7-50 c. in the controls in case the logs were used for a *covered* bridge. Already nine months after the cutting of the trees *Oryctes* beetles were found in the controls."

With reference to the above experimental work and the suggested practical results, the figures would have been more convincing if the pits had not been placed alongside one another. It appears to the reviewer that the beetles would follow the line of least resistance and breed in exposed in preference to going to the trouble of finding the covered, breeding places.

The practical experiment at Padang certainly confirms the results obtained from the pit experiments but the fact that "*nothing* was found however even not in rubbish on which only a few inches of sand had remained" implies that there is a very great possibility of sand being washed off and the rubbish becoming a suitable breeding ground unless strict and continuous supervision is exercised.

The top dressing with sand or market refuse as a general practice in Malaya is not supported by the reviewer who objects to it on the grounds of sanitation, difficulties of obtaining suitable material for covering and supervision affecting the liability of accidentally encouraging the propagation of the black beetle if the refuse is exposed by washing.

The question now arises since top dressing is open to criticism can village refuse and manure heaps be destroyed?

The reviewer appreciates the difficulties attending the disposal and destruction of village refuse and manure heaps. He has seen such heaps burning on the surface and grubs below seemingly not being inconvenienced in any way.

Village refuse and manure heaps can however be destroyed in simply constructed inexpensive incinerators.

It may be mentioned, though such an incinerator and its possibilities will be described in the next number of the Agricultural Bulletin, that four days' fresh market refuse from a village was burned in about three hours, and a heap of such material which had been accumulating for about one year and therefore wet and heavy was destroyed in three weeks.

"The larvae of the *Rhinoceros* beetle were never found in smaller parts of logs. Therefore cutting the logs first into pieces of one yard and splitting the pieces longitudinally in four parts, will generally prevent the development of the grubs. Another method is burying and covering the logs with eight inches of soil. Splitting, drying and burning can also be applied successfully. The trunks remaining in the ground, need not be uprooted, but must be cut off as low as the soil level and afterwards covered with a layer of sand of eight inches."

The reviewer considers that *the burying of logs is an objectionable practice*, even if well done. It is not uncommon to find the trunks of coconut trees supposed to have been buried appearing above ground after a short time, but from the sanitation point of view *the burying of rubbish and logs should be deprecated.*

In the Agricultural Bulletin of the Federated Malay States, Volume VI, No. 6, March, 1918, is an article by South on "Buried Coconut Trunks and Root Diseases of Rubber" in which he states referring to a certain estate that "after this discovery (viz., that a badly diseased and decayed root of each of the rubber trees attacked by root disease ran into one of the pits in which coconuts had been buried) all the coconut pits were opened up and the decaying trunks were taken out, split up, and piled cross wise to dry before being burnt." "It was remarkable how little the larger fibrous portions of the coconut had decayed." "The trunks had been buried between three or four years."

In the Quarterly Report from October to December, 1920, of the Assistant Agricultural Inspector, Perak (Mr. F. Birkinshaw), is found ".....Estate has cut out several acres of coconut. In this case the trees were felled below the ground level, split up, straight away and the pieces piled up to dry. At the end of December burning had been commenced upon the split trunks. This method of dealing with felled coconut trees is one which might be followed by others with advantage to all concerned. It may be mentioned that not only are recently felled trees being cleared up in this effective way but trunks previously buried are being unearthed, split and dealt with in the same way. Some of the buried trunks have been underground for nearly two years and yet on being unearthed many of them appear to be as hard as when they are buried."

The importance of burning logs and trunks to prevent "white ants" causing troubles need not be emphasized.

Though the burying of coconut stumps is permitted by law in Malaya the wisest procedure to follow in dealing with coconut stumps is to cut up, pile, and burn and thereby prevent all dangers associated with the burying of coconut stumps and logs.

"An old recommendation is to examine the crown of the tree for beetle holes, and to kill or extract the beetles with a piece of wire. Afterwards the holes must be filled with woodashes, clay, sand, or a mixture of sand and salt. The present author used a mixture of one part of coarse salt and two parts of seasand, the hole was filled with this mixture and then closed with clay. This method was successful. This mixture does not harm the palm and protects the inner parts from decay."

"Experiments with light traps did not give any result nor could the beetles be trapped by hanging the husks of young fruits in the trees.

"Against the larvae the best direct measure is to catch them in heaps of refuse and to kill them here regularly. This measure is indispensable for estates so long as no legal measures in native gardens are practised. Keeping controlled pit traps at the frontiers of the coconut-estates can be effective in keeping beetles away from the estate."

"Though pit traps were often advised in previous publications many questions remained unsolved and were yet to be answered."

"The best results were obtained by (using for pit traps) the vegetable refuse collected in towns and on markets and the waste of the nipa palm industry." "The optimum attraction for beetles in small quantities of refuse 2 M.³) is reached after three months and after eight or nine months no more beetles are attracted for egg laying and the rubbish has entirely changed into humus soil." "The length of the larval stage indicates that the intervals between searching (the pits) must not exceed three months, but it is more advantageous to search every six or eight weeks."

"The results of the experiments with poisoning the trap-heaps were very good, at least of the experiments with sodium arsenite and Paris green. It was established, that quarter per cent. of one of these poisons on a certain amount of breeding material did not affect the attractiveness for the beetles. Notwithstanding the poison they came regularly to deposit eggs but the larvae never developed! The poison remains effective during the whole length of time that the refuse remains attractive to the beetles for egg-laying. Therefore if regular control is impossible, poisoning the trap-heaps with the aforementioned poisons renders good service. As the poisons remain so long active that even after nine months nothing will grow upon it, poisoned refuse cannot be used for manure during a long period (more than nine months)."

Final instructions in this excellent paper are given concerning the grub traps.

When supervision can be exercised there is no doubt that pit traps would be found very useful in clearing Rhinoceros beetles from a particular area but, if strict control was not practised, the conditions arising from the use of pit traps might be worse than those previously existing. To depend upon the owners of small kampongs in Malaya regularly collecting beetles, grub, etc., in the pits would very likely end disastrously.

The poisoning of heaps intended for manurial purposes might be recommended in extreme cases, but the fact that more than nine months must elapse before using tends to preclude any advantage which might accrue from this practice.

To sum up the reviewer is convinced that if the Estate Managers and *Kampong* Cultivators in Malaya were to destroy the breeding places in the vicinity of the coconut palms, and the village authorities show active interest in the destruction of village refuse these would be no need for adopting other control measures for *Oryctes*.

G. H. C.

AGRICULTURAL EDUCATION.

By D. H. GRIST.

(1)—AGRICULTURAL EDUCATION IN CEYLON.

DURING a recent visit to Ceylon the writer was given an opportunity of studying the system of agricultural education obtaining in that Colony. After detailing the system as there operated, suggestions will be made as to the application advisable for the Federated Malay States. A study of the Ceylon system is valuable because agricultural instruction has there been a settled policy of the Government for about twenty years; and in spite of mistakes that have been made, very material advances have taken place, and the present system would appear to have an assured success.

The following is a brief statement of the educational activities of the Ceylon Government. Under the present system, the direction of all agricultural policy, whether directed towards the training of teachers or others, or in the management of school gardens, is under the sole direction of the Department of Agriculture, assisted, in the matter of school and home garden work, by local education committees. The only exception to this rule appears to be in the elementary botany and school garden work taught to vernacular teachers in the Training College for Teachers, Colombo.

At one time there was an Agricultural College at Colombo, directed by the Department of Public Instruction. It was closed in 1900. The reasons given for its are thus stated:

“The work of it was defective simply because the students who went there did so because they thought that they could get Government employment—not Government employment in the Agricultural line—but in other lines.”*

Thus, it is supposed that the college attracted the wrong class of student, and this was, in fact, brought about by an unsuitable curriculum.

Too much time was devoted to theory, and too little time devoted to the practical work.

The School of Tropical Agriculture, at Peradeniya, founded in 1916, more effectually filled the needs of the Colony. Its course is of an elementary nature, and stress is laid on practical work in the field. In the class rooms, lectures and demonstrations are given; while in the field, students are taught how to handle implements and animals, and the field operations in connection with tea, rubber, cocoa, coconuts and other Ceylon products.

* Agricultural Training in Ceylon—XXXVII—1909.

The school was designed to attract the following classes of students :

- Firstly.*—The sons of well-to-do agriculturists;
- Secondly.*—Students who intended to devote their careers to practical agriculture as managers or sub-managers of estates;
- Thirdly.*—To produce recruits for posts in the Agricultural Department;
- Fourthly.*—To provide special classes for the benefit of elementary school teachers, who intended to impart tuition and nature study in the elements of rural economy in village schools;
- Fifthly.*—To give village headmen (corresponding to “penghulu” and “lembaga” in the Federated Malay States) short courses in rural economy, in order that they might, by precept and example, encourage sound agricultural practice in their respective parishes.

The present staff consists of the Director of Agriculture as Principal, a Registrar, three lecturers and demonstrators, a lecturer in estate accountancy. With the exception of the Principal, the staff is drawn from the natives of Ceylon. The lecturers have undergone a course of agriculture at the Ceylon Department of Agriculture, and obtained the Poona Diploma in Agriculture. In addition, the scientific officers of the Department of Agriculture give occasional lectures in the subjects in which they are experts.

There are two main courses of instruction :

- (1) A two-year course in the English language—At the present time there are twenty students undergoing their first year of this course, and twenty in their second year;
- (2) (a) A Singhalese Teachers’ Class of about twelve certified teachers from the Educational Department—They undergo the first year’s course only, similar to the English students but delivered in the Singhalese tongue;
- (b) A village headmen’s course of one year, consisting of the ordinary first year’s course revised to meet the special requirements of their particular needs.

Vernacular teachers and headmen are admitted to a one-year course in alternate years.

The school is housed in two hostels, and all students pay tuition fees of Rs. 7.50 per mensem, and hostel fees of Rs. 22.50 per mensem.

The school certificate covers the course of instruction of two years. It is given partly on note-book and field-work, and partly on examination results. Special certificates are granted for the

vernacular courses. In addition, various prizes are granted in connection with all classes. Scholarships are offered by the Government for the most promising of the students to undergo further training in India.

The courses are largely practical. Each student has a garden to keep in order, and the writer was struck with the keenness shown by the students in the upkeep of their plots. During his visit he also attended lectures in co-operation and accountancy which gave him an idea of the thorough nature of the instruction.

In addition to the above-mentioned activities, the students have a Students' Council which represents the needs of students; a Debating Society, which meets weekly for the discussion of matters of agricultural interest; and a school magazine of an agricultural nature, edited and managed by the students themselves.

A word as to the men produced at the school may not be out of place. The posts in the Agricultural Department filled by former students include sub-inspectors, men for special food campaigns, officers for the co-operative societies, and assistants for the various technical branches.

The Secretary of the Low-Country Products Association stated that there were fourteen old students employed on estates registered with the Low-Country Products Association. "He was pleased to testify to their good work. He found them to be sound, good, reliable boys, and certainly two of them were outstanding men."

THE TRAINING COLLEGE, COLOMBO.

All vernacular teachers at the Training College, Colombo, pass through a course of training in Elementary Botany and Physiology. They have a small college garden, useful for the supply of matter for botany lessons. The botany instruction is thorough. Many of the students' note-books were examined by the writer. They were works of art.

As a preliminary training prior to admission to the School of Tropical Agriculture, the teaching of the Training College is useful; but the garden is too small and the land poor. As mentioned above, the botany work of this college is under the Education Department.

MIDDLE SCHOOLS.

The Director of Agriculture has divided the island and has placed a Divisional Agricultural Officer in each division. One "Middle School" is to be erected in each division, under the supervision of the Divisional Officer. It must be realized that Ceylon shows a wide diversity of agricultural conditions. The middle schools—i.e., intermediate to the School of Tropical Agriculture and village schools, is designed to meet the requirements of each particular local condition,

Vernacular teachers will be trained in such schools: An experimental station will be attached, and distribution of seed, etc., to village schools and individuals made from this centre.

SCHOOL GARDENS.

School gardens were taken over by the Department of Agriculture in 1906. They have accomplished good work and have also been the means of distributing several improved types of vegetables throughout the Colony. The avowed policy of this department is thus stated by the Director of Agriculture, Ceylon: "It is impossible to teach agriculture in the elementary schools and it is important teachers should realize that the main object of a school garden is to provide material for nature lessons, and to provide common objects of ornamental and economic importance with which to train the powers of observation of the pupils." In point of fact, the writer is of opinion that training in agriculture is given in such schools, that the boys are taught the production of local crops with the definite intention that they themselves on leaving school, may apply the school experience on a larger scale. It is probable that the present practice of agricultural education is more suited to the local needs than the impersonal nature study of which the gardens were merely to provide the material.

School gardens are of two classes—the village school and the central school gardens. In the latter conferences of school teachers are held, and demonstrations are conducted. To take the schools as the writer found them, the majority of head teachers had been through no instruction at the School of Tropical Agriculture. In spite of this, the keenness displayed in this class of work, both by teachers and boys, is the best recommendation of its effectiveness or utility. At the present time there are 484 registered school gardens throughout the Colony and many more await registration. The organization of school garden work is entirely in the hands of the Agricultural Department and all matters relating to the garden work is referred to the Director of Agriculture and not to the Education Department. The executive is controlled by the divisional officers who are Europeans trained in scientific agriculture. Under these officers work a native staff which include Agricultural Instructors and Inspectors of School Gardens. The Instructors only visit school gardens as their other work permits, while the latter devote the whole of their time to instructional work in schools, planning gardens, judging gardens for prizes and procuring the plants and equipment for the various schools.

The students in vernacular schools spend one hour a day in the garden, which may vary in extent from $\frac{1}{4}$ acre to two acres.

HOME GARDENS.

An important off-shoot of school garden work is the home garden scheme. The boys are encouraged to apply the teaching of the school garden in the cultivation of plots at home. There are now about 24,000 home gardens in Ceylon.

Of the best school gardens visited by the writer may be mentioned the following :

Owiteganuwa Vernacular School with 250 boys had about 200 home gardens.

Narandeniya School with 250 boys had 150 home gardens.

It should be pointed out that whereas school garden work is compulsory, home gardens are voluntary. So important has this branch of work become that Inspectors of home gardens are to be appointed.

In connection with both school and home gardens, prizes are awarded for meritorious work.

LITERATURE.

A primer of tropical agriculture, adapted as a reader for schools, and a senior agricultural reader are the only agricultural books in use, and inadequate. In addition, a journal which records the results of experiments and investigations in native products and of co-operative credit societies is printed for Singhalese readers and a somewhat similar organ in Tamil.

CO-OPERATIVE CREDIT SOCIETIES.

These form an essential link between agricultural education and agricultural practice. Frequently the application of better methods involves the expenditure of more money than the native can afford. To produce larger crops, the planter must make the soil his bank. A co-operative society is the only means by which a poor man can hope to procure loans for approved purposes. It may also become his bank in which to deposit his savings. Co-operative societies thus not only provide the means of increasing profits, but encourage thrift. The working of such societies need not be discussed in this place. It is only necessary to the state that each village co-operative society should be self-supporting. The venture should not be a government one, and the initial capital should be raised locally.

In Ceylon, co-operative societies are of growing importance. In 1919 there were 127 societies, 30 of which had been formed during the year. The total membership of the societies was 15,160 and the paid up capital Rs. 86,721.46. Government loans were granted to the amount of Rs. 13,935.

Government have a controlling influence only on such societies. They provide Inspectors, but the internal arrangements are local and the Government takes no responsibility other than that of encouragement and audit.

The Indian societies are controlled in the same manner.

Other educational activities of the Ceylon Department of Agriculture may be but briefly stated. They include assistance and encouragement in village agricultural shows and in demonstration plots. The latter exist in various parts of the Colony and no doubt assist in a considerable degree in the work of

dissemination of knowledge and the application in practice of the valuable results attained by the scientific officers of the department.

In passing, the writer would like to record his grateful appreciation of the assistance given to him by Mr. F. A. Stockdale (Director of Agriculture, Ceylon), and the officers of his department. Mr. Stockdale arranged with his officers a tour for the writer that embraced a survey of all the activities of his department. The writer's thanks are due also to the assistance accorded him by the Education Department, and also to the Ceylon Government for providing a free pass over the Ceylon Government Railway, and for assistance in other directions.

(2)—AGRICULTURAL EDUCATION FOR MALAYA.

The prosperity of the Federated Malay States is largely dependent on its agricultural resources, and the development of these in the past has been devoted almost entirely towards the production of rubber. Of the planted area under this crop in 1918 (nearly a million of acres planted) over thirty per cent. was held in areas of less than one hundred acres each. This would appear to be a fair average of the amount of rubber land held in the Federated Malay States by Asiatics. The opinion has been forced on those who have been engaged on rubber disease work in this department, that the land so held by natives constitutes a menace to the industry.

Through lack of cultivation and neglect of precautionary measures, these holdings are often found the centre of infection of serious plant diseases, and considerable difficulty is found in forcing the owners to remedy this deplorable condition. It follows too, that the owners of such estates do not obtain as much profit as they might. In this way, the general prosperity of the country is hampered. A Ceylon worker states that efficiency in agriculture amongst natives is a third less than when under European management. In this country the loss through inefficiency is probably greater.

Another problem of growing importance in this country is production of food-stuffs. The main crop of this nature—padi, does not yield, under native management, profitable crops; and it is advisable that the cultivation of other crops of economic value be taken in hand. It would appear that although Malays are an agricultural race, yet they lack the "agricultural instinct." The solution of these problems is to be found in education. The building up of the scheme may be slow, especially as the number of trained Malays is few, but it would appear possible to commence building up a system from the Agricultural Department downwards, which would ultimately prove of great value in educating the Malays, and prove a valuable link between the Agricultural Department and the native cultivators.

There are two branches of the problem. The improvement of existing areas under cultivation involves certain necessary steps to bring the present cultivators—men of mature age—in

touch with the work of the department. It is useless to think of education, in the ordinary sense of the word, in this connection. Much may be done however, by the establishment of demonstration stations. In these stations no experimental work should be undertaken. It is not desirable that the native should see the failures, but he should have every opportunity of seeing the advantages of cultivation of crops of known worth, which are suitable for his particular district. The officer in charge of this work must, of course, have his experimental station where he can test his crops before introduction to the demonstration stations. These latter stations thus have a distinct educational value, and moreover, serve as distributing centres for seed. Effective demonstration appeals to the eye, a much more reasoning organ with the average Malay than is the brain.

A second method of encouraging agriculture amongst Asiatics is by stimulating them towards co-operation.

Co-operative credit societies have done much good work in India, Ceylon and elsewhere. Such societies should be encouraged, although the actual working of them must be in the hands of the shareholders themselves.

THE FUTURE DEVELOPMENT OF AGRICULTURE.

The future of agriculture in this country is in the hands of those who sit in our schools. At present, they have minds receptive to new ideas; in a few years, if steps are not taken to give them correct impressions, they will have similar ideas and customs to their fathers. It is then, upon this material that our energies towards agricultural instruction should be directed. The writer proposes that agricultural instruction should be included eventually in the curriculum of every school and college in the country. The objects of school gardening have been stated very clearly in an article published in the *Journal of the Department of Agriculture, Ireland*:

“The objects are first and foremost educational, and aim at improving the general education of the child, rather than adding another subject to the curriculum (already over-crowded) for the child to learn. It is rather as a means to an end than as a subject that it is introduced, although much might be said for it as a subject pure and simple. It is not the intention to train skilled gardeners or farmers . . . but rather to train pupils full of resource and initiative, with confidence in themselves, and having an alert mentality well stocked with common sense. It is urged that pupils taking up this subject have always something to do, both with their hands, eyes and brains; some definite problem to tackle, observe and to await results of. As a consequence, they become intensely interested, and their powers of observation, thinking and reasoning, soon show signs of development.”

In some of the Ceylon schools, it has been observed that there is a tendency to plant up a considerable area with one crop in a district where the teacher is aware that there is a market for the commodity. The pupils must not be exploited in this way, and while it is no doubt a good thing to stimulate in the child interest in the market side of the question, yet it is essential that the school garden should not be considered as a "market garden" but rather, as an "out-door school."

The teaching of agriculture in schools, attempted in many countries, has now been abandoned. Agricultural education is too technical for this purpose. Rural education such as is proposed embraces nature study coupled with an elementary knowledge of the systems employed in . . . in the cultivation of well-known crops. Nothing in the nature of "experiments" are conducted, for such a course leads to confusion in the pupil's mind.

It is evident that in this work the teacher is the vital factor. A profound knowledge of agriculture is not essential, and is possibly a mistake. There is a wide difference between knowledge of a subject and knowledge of the methods of instruction in the subject. It is hoped that in the Tanjong Malim Training College part of the teacher's course in agriculture may be devoted to the instruction in the methods of imparting his agricultural knowledge. In Ceylon, although agriculture is taught in over four hundred schools, yet quite a small proportion of the teachers engaged in the work have been through any course of instruction in agriculture. But they have been through a training college for teachers, and have applied their training, with success, on a subject of which they possess but a slight knowledge. It must not be forgotten that on the technical side they receive help from the Instructors of the Agricultural Department.

The writer would point out that although it adds to efficiency for teachers to have had some agricultural training, yet provided that the "staff work" of the Agricultural Department is good, the scheme need not be held up on this account.

Schools in Ceylon, where garden work is included in the curriculum have first to be approved by the Director of Agriculture and the Director of Education. Provided that the former's representative certifies that the work has been efficiently carried on during the year, the head teacher receives a bonus. Certificates are also presented to school teachers for exceptionally good work. There is great competition amongst teachers in some districts to obtain this award. The writer was informed that the teachers valued such certificates more than the bonus, which practically every school received.

HOME GARDENS.

"This extensive movement is an appropriate corollary to the main scheme, and is calculated to bring its benefits home (in more than one sense) to the rural population. Home gardens should prove an important educative factor, giving, as they do,

to the boys a sense of ownership and personal responsibility, encouraging in them the spirit of enterprise, and last, but not least, making them realize the power (and pleasure) of production."

The introduction of the home garden scheme into Ceylon although of relatively recent date, has been an unqualified success. It proves that the system and general teaching of gardening in the schools has gained its object in stimulating the pupils with an intelligent interest. Should the training of rural economy be adopted in this country, efforts would be made to introduce home gardens at an early date.

The scheme of training suggested for vernacular teachers in the new Tanjong Malim Training College, and the general policy of the Agricultural Department with regard to agricultural instruction should be in concord. It is suggested that the Agricultural Instructor, Tanjong Malim Training College, be an officer of the Agricultural Department.

The question of the establishment of a School of Tropical Agricultural, based on the lines of the Ceylon school is worthy of consideration. For the instructional work of this department it is essential that the Malay officers have a thorough knowledge of their subject. At the present time the scientific officers of the department train thier own officers and the probationers are moved about from one division to another in order to acquire as good a general knowledge of the divisions as is possible under the circumstances. This would appear to be but a temporary expedient. The training of such officers would be more thorough and be less likely to interfere with the normal duties of the scientific officers, if there was some central school where the necessary training would be imparted.

The system of "middle schools" as known in Ceylon need not be contemplated in this country. The conditions of agriculture in different parts of Malaya show less variation than in Ceylon, so that a central school could deal with practically all our local systems of crop production.

The outlines of the steps necessary towards organized agricultural instruction have now been stated. To enumerate:

1. A central School of Tropical Agriculture;
2. The Tanjong Malim Training College (Agricultural Branch);
3. School garden scheme;
4. Home gardens;
5. Demonstration stations, and Instructors' experimental stations.

The Director of Agriculture has already submitted suggestions for the establishments of a special division of the Agricultural Department to deal with agricultural instruction. The scheme detailed above would be the functon of this division.

CULTIVATION OF "TENGGALA" PADI—(cont.)

By D. H. GRIST AND SYED ABDUL RAHMAN.

EXPERIMENT A.

THE EFFECT ON YIELD OF WEEDING "TENGGALA" PADI.

The experiment was conducted in duplicate on plots of quarter acre. Apart from the weeding, the cultural operations were similar on all plots. The land was ploughed three times, and the variety "Jambak Bawang" broadcasted at the rate of 34 lbs. per acre. The dates of the cultural operations are given in the table below.

TABLE 8.

Dates of weeding—Weeding Experiment of Tenggal Padi.

Year.	Plot Ref. No.	Treatment.	Planted.	First weeding.	Second weeding.	Third weeding.	Flower.	Harvest.
1917	40	No weeding	19-9	—	—	—	15- 1-18	9- 3-18
"	41	Once "	19-9	27-11	—	—	14- 1-18	12- 3-18
"	42	" "	29-9	26-11	—	—	15- 1-18	13- 3-18
"	43	" "	20-9	19-11	—	—	13- 1-18	12- 3-18
1918	57	No "						4- 1-19
"	56	Once "						3- 1-19
"	55	Twice "						2- 1-19
"	44	Thrice "						1- 1-19
1919	86	No "	18-7	—	—	—	20-11	30- 1-20
"	88	Once "	18-7	28-9	—	—	20-11	29- 1-20
"	87	Twice "	18-7	26-9	26-10	—	21-11	19- 1-20
"	89	Thrice "	15-7	25-9	25-10	6-11	18-11	27- 1-20
1920	98	No "	1-7	—	—	—	2-11	9-12-20
"	99	Once "	1-7	14-8	—	—	3-11	16- 1-20
"	101	Twice "	2-7	14-8	14-9	—	3-11	15- 1-20
"	100	Thrice "	2-7	14-8	14-9	12-10	3-11	15- 1-20

Owing to the lateness of the season, the full programme of weeding could not be followed in 1917. In that year, the plots suffered to some extent from the attacks of birds and insects.

1918—was a normal year.

1919—was a good year, the crops being little damaged by pests. In this year plots 86 and 87 "lodged."

1920—The crops began to fall off in this year, as the land has not received any manuring since opened in 1917.

TABLE 9.

Yields of Padi—Weeding Experiment.

Year.	Plot Ref. No.	Treatment.	Yield in gantangs per plot.	Estimated yield per acre. Lbs.	Estimated Yield per acre of	
					Grain Gantangs	Straw Lbs.
1917	40	No weeding.	45	987	180	3,139
1918	57	"	58.5	1,245	234	6,623
1919	86	"	40.5	888	162	4,144
1920	98	"	34 $\frac{1}{4}$	776	137	3,512
¹ 1917	(Average)	Once weeding.	...	1,164	242	3,522
1918	56	"	71	1,510	284	5,958
1919	88	"	44	1,106	176	3,703
1920	99	"	32 $\frac{1}{4}$	741	129	3,056
1918	55	Twice weeding.	62 $\frac{3}{4}$	1,335	251	8,288
1919	89	"	49 $\frac{1}{4}$	1,115	197	4,256
1920	101	"	24	544	96	3,416
1918	54	Thrice weeding.	49 $\frac{1}{2}$	1,118	198	6,496
1919	87	"	44	899	176	3,724
2920	100	"	32 $\frac{3}{4}$	742	131	2,740

(1). The figures for the three plots were as follows:

Plot Ref. No.	Yield in Gantangs per plot.	Estimated yield per acre. Lbs.	Estimated yield per acre of.	
			Grain Gantangs.	Straw. Lbs.
41	52	1,055	298	3,751
42	48	1,089	192	2,953
43	59	1,347	236	3,862

Note.—1 Gantang=1 Gallon.

TABLE 10.

Average results 1917-1920 Weeding Experiment.

(Compiled from table 9.)

Treatment.		Estimated yield per acre of grain in		Estimated weight of straw per acre in Lbs.
		Lbs.	Gantangs.	
No weeding	...	947	178	4,354
Once	„	1,130	208	4,960
Twice	„	998	181	5,320
Thrice	„	920	168	4,320

These tests are incomplete, and it must be admitted that no great advantage of weeding has been proved. As against this it must be remembered that it is probable that the experimental plots are better cultivated, and therefore naturally, cleaner than similar land under native cultivators.

In 1920 several of the "variety plots" at the experimental station unaccountably grew more weeds than usual, and in consequence, the yield of padi was materially less.

EXPERIMENT B.

DIBBLING VERSUS BROADCASTING PADI SEED.

Local custom ordains hat "tenggala" padi seed shall be broadcasted. Presuming the general conditions of this crop to be similar to the cultivation of cereals elsewhere, where the drilling of the seed is practised, it is reasonable to suppose that padi would give an increase in yield if it were dibbled. In the absence of machinery, this operation, was in these experiments, performed by hand. The annual operations are here stated.

The land was first brought under cultivation in 1917, prior to which it had been fallowed for some years. Having cleared off the scrub, the soil was ploughed three times and raked once. Dibbled seed was sown at the rate of 85 lbs. per acre, broadcasted seed at the rate of 160 lbs. per acre (in both cases on quarter acre plots). The experiment was conducted in duplicate. The results may be variable on account of the rate in sowing,—but it was found that the seed was unduly close when planted by the dibbling method if a greater quantity of seed was used. Dibbled seed was covered by hand, and the broadcasted seed by means

of a light plough. The distance between clumps in dibbling was about 10 inches. The variety of padi used through out this experiment was "Lebat Chantek." The results are shown in the tables which follow:

TABLE 11.
Yield of padi seed dibbled.

Year.	Ref. No. plot.	Yield per plot in		Yield per acre.		Straw per acre in	
		Gantgs.	Lbs.	Gantgs.	Lbs.		
1917	44	30 $\frac{3}{4}$	734	123	2,314		
"	47	38	888	152	2,554		
1918	59	31	680	134	5,362		
"	60	18 $\frac{1}{2}$	404	74	3,798		
1919	91	47 $\frac{1}{2}$	1,074	192	4,868		
"	92	32 $\frac{1}{4}$	730	129	4,385		
1920	102	18 $\frac{1}{2}$	421	74	3,192		
"	104	43 $\frac{1}{2}$	986	174	3,092		

In 1917 the seed was sown on 22nd September, 1917, the rows being 18 inches apart, weeding 25th January, 1918, reaping 15th March, 1918. Weeding was found necessary on dibbled plots only.

In the 1918 season, the crops were reaped 12th January, 1919, and in the 1919 season on 2nd February, 1919.

In 1920, the seed was sown on 2nd July, 1920, and the crops harvested on 16th January, 1921.

TABLE 12.
Yield of Padi—Seed Broadcasted.

Year.	Ref. No. plot.	Yield per plot in		Yield per acre in		Weight of straw per acre.	
		Gantgs.	Lbs.	Gantgs.	Lbs.		
1917	45	44 $\frac{3}{4}$	1,010	179	3,740		
"	46	57	1,436	228	6,372		
1918	58	41 $\frac{1}{4}$	910	165	5,948		
"	67	46	1,009	184	6,955		
1919	90	44 $\frac{1}{4}$	996	177	5,410		
"	93	65 $\frac{3}{4}$	1,552	263	3,527		
1920	103	32 $\frac{1}{4}$	741	129	2,760		
"	105	48	1,115	196	3,968		

The cultural operations were similar in each year, and for each plot of the experiment, except for the mode of sowing and the fact that dibbled plots always required on the weeding. In 1920 the same quantity of seed was sown on broadcasted plots as on dibbled plots.

TABLE 13.

Dibbling versus Broadcasting.

Average of Results of Year 1917-1920. Compiled from Tables 11 and 12.

Treatment.		Yield per acre in		Weight of straw per acre.	Percent grain to straw.
		Lbs.	Gantgs.	Lbs.	
Broadcasted	...	1,003	175	4,018	20.0
Dibbled		701	127	3,388	17.1

The conclusions point to the fact that broadcasted padi gives a larger yield than does dibbled seed, the incr ase amounting to over 30 per cent. Doubt still exists as to whether this increase is due in part, or entirely, to variation in rate of seeding, but . . . for reasons stated above it is doubtful whether this cause would have so great effect. Experiments will be continued to decide this point.

EXPERIMENT C.

CONTINUOUS CROPPING WITH TENGGALA PADI.

An experiment was designed to test the effect of the continuous cropping of tenggala land with padi, without the use of manures.

Padi "Lebat Chukor" has been for this purpose. The plot is one acre in extent. The annual treatment of the land is ploughing three times, and raking in the broadcasted seed, applied at the rate of ten gantangs per acre.

The results to date are noted in the following table:

TABLE 14.

Continuous Cropping with "Tenggala" Padi.

Year.	Ref. No. plot.	Date of harvest.	Yield per acre in Lbs.	Yield per acre in Gantangs.	Straw per acre Lbs.	Remarks.
1917	39	3-3-18	870	149	3,048	Rats destroyed a small portion
1918	53	6-1-19	467	82 $\frac{1}{2}$	3,027	Attacked by coroctata, birds and rats to some extent
1919	85	17-1-20	628	106	3,272	Do.
1920	...	3-1-21	791	139 $\frac{1}{2}$	3,903	Weeds effected yield Hot weather during early growth

The local system of cultivation allows for four crops of padi to be removed, and for the land to lie fallow for from four to six years. This would appear to be a too hard and fast rule. It is evident that in the above experiment, average crops may be expected for another two or three years, as, owing to the attacks of insects etc., the crops have been very small. This constant worry of the attacks of pests is not peculiar to the experimental grounds in this district, the annual damage to the crops in the district being very considerable.

EXPERIMENT D.

ROTATION OF CROPS FOR TENGGALA PADI LAND.

As previously stated, the cultivation of dry-land padi under this system allows for no continuous cropping of the land. After the harvesting of four or five crops, the padi land reverts to small scrub, or grass-land of inferior quality, on which the not too numerous buffalo find their food. Thus, with a total area of about 5,000 acres of land cultivated with "tenggala" padi in the Pekan District, there is only about 1,000 acres cultivated in any one year. The loss to the district is considerable. In addition, the area of land suitable for "tenggala" padi is capable of extension. A suitable rotation of crops would tend to bring in a larger area under the crop, would stimulate the cultivation of other annuals, and provide more nutritious food for the cattle.

The experiment put in hand is designed to produce the greatest number of cereals crops as is possible, and to be an application on a slightly larger scale of the catch-crop and cover-crop and cover-crop work already described.

The area chosen for this experiment is one acre in extent. Prior to 1917 it had been under grass for a considerable number of years.

TABLE 15.

Rotation Experiment.

Year.	Crop.	Yield per acre Lbs.	Yield per acre Gantangs.	Straw per acre. Not removed from land.	Remarks.
1917	Padi	793	148 ¹ ₂	3,135	Variety "Bendang Sri"
1918	Centrosema	354	—	—	
1919	Padi	1,085	192	4,096	Do.
1920	„	1,020	180	4,224	Do.

The treatment of the land and dates of cultivation have been as follows:

Plot 44—

1917.—Land cleared of scrub, thrice ploughed and once raked. Padi "Bendang Sri" sown broadcast at the rate of 32 lbs. per acre, and raked in on 8th October, 1917. The land was weeded on 24th January, 1918, and the crop harvested on 1st June, 1918. The preparation of "tenggala" land was late in this year, owing to an outbreak of disease amongst cattle. The plot suffered from the attacks of various insect pests.

1918.—After the removal of the padi crop, the land was twice ploughed and 60 lbs. of *Centrosema* broadcasted in May. It was somewhat late for planting, owing to the difficulties of the previous year. The centrosema made rapid progress in the latter part of the year. The crop was ploughed under in 1919.

1919.—The land was ploughed three times and once raked. Padi "Bendang Sri" sown broadcast at the rate of 32 lbs. per acre on 12th July, 1919, weeded on 13th September, 1919, and flowered 15th November, 1919. The plot was attacked by *coroctata* (8 lbs. of this pest were collected from the plot by hand). At flowering time, the larger portion of the crop lodged. A small portion of the plot was attacked by pigs. Harvesting commenced 14th January, 1920.

1920.—Ten loads of farm yard manure well spread over the plot fifteen days before the first ploughing. The land was ploughed four times, the seed sown broadcast, and raked in. It is proposed to crop the land once more with padi in 1921.

The experiment is, of course, inconclusive at present. The writers are of opinion that, with the crops (other than padi) which they have proved of value in this District, it is most certainly possible to retain under cultivation the tenggala land in Pahang.

VARIETIES OF PADI TENGGALA.

The following is an account of the origin, as far as is known, the botanical and other features, of the varieties of padi "tenggala" grown on the Experimental Grounds at Pekan, Pahang in the seasons 1917-1920 inclusive. The padi tested embraces almost all the varieties known in the Pekan District. An examination has not been conducted of the varieties grown in the Kuala Lipis District.

YIELD.

The observations on the comparative yields of the varieties of "tenggala" padi are as yet incomplete. Sixteen varieties have been tested throughout four seasons. The details of the

figures obtained will be found in tables 16 to 31 inclusive, and the statement of the average results in table 36. Three varieties have been tested for three seasons only. The results are stated in tables 32 to 34 and the average results in table 37. Fifteen varieties have been under test for two seasons (1919 and 1920), the results of which will be found in tables 35 and 38. Records of nine varieties, tested in 1920 only, will be found in table 39.

In every case the padi was planted in plots of one-fortieth of an acre. The land received the usual cultivation as described in the first pages of this report. The seed was sown broadcast, at the rate of six gantangs per acre. In 1917 the land was newly opened up, after a period of several years fallow, and the work has been continued from that time in the same situation. There appears to be little falling off of yields thus far on account of the exhaustion of the soil through over cropping. The land on which these tests are made is said to be about average in quality for the padi soils of the district.

Padi are of three classes, as follows:

- (a) "Gansa" or "Padi Keras" is the hard grained padi generally found, and in general use. The essential feature is a vitreous grain;
- (b) "Lambut." Soft grained padi of a semi-opaque appearance. Used for general purposes and for cake making;
- (c) "Pulut." Soft grained and opaque—often waxy grain. Used for ceremonial purposes, cake making, etc. "Pulut" becomes sticky on cooking.

The highest yields are obtained from padi which is now purely "tenggala," or from those varieties which have originated from "wet padi" and can be used as either wet or tenggala padi. Padi which are really "dry" (or hill padi) and until recently were always cultivated as such, have given but poor returns when grown under the "tenggala" system. This is due to lack of acclimatization, and in part, to the fact that less selection work has been carried out on them by the natives. The system of dry land padi cultivation has, until recently, been in the hands of the Sakai, who take one or two crops of padi from a clearing, with the minimum of cultivation, and then move to another place. This haphazard method is not conducive to the improvement of the stock.

It is a curious feature that two varieties, formerly cultivated by the Malays as "padi tenggala" should have become so mixed in character that their individuality has been lost. These two varieties—Padi "Muntit" and Padi "Bunga Memachang" have been selected from a crop of padi Lebat "Chantik" by the writers, and, as far as records have progressed, show a superiority in yield over any other variety that has been tested. The reason why these two varieties should have been lost by the Malays is not clear; for now that they have again been isolated there has been a demand from the Malays for the supply of seed for planting purposes.

The results of yields on the experimental plots prove to be about three times as great as the average yields in the District of Pekan. The causes of this difference are probably as follows:

- (a) A 17 per cent. increase on account of weeding;
- (b) The district figures include areas where the entire crop may have failed or been destroyed by flood;
- (c) The care taken on the Experimental plots to guard the crops from the attacks of its natural enemies,—birds insects, rats and pigs;
- (d) Improved and careful cultivation, and planting in the proper season;
- (e) Improved seed, and careful selection of seed.

The question of the effect of improved seed is placed last on the list, not because there is a doubt of the improvement but because the seed is yet far removed from perfection, so that little claim is made on this account.

In the selection of the variety for cultivation, the native appears to favour a padi which, above all things, is hardy. To obtain this desideratum, he frequently plants varieties which have little else to recommend them than hardiness. A great deal might be done towards selecting the padi most suitable for the particular conditions of each padi area.

To particularize on the varieties of the padi tested, and which have been tested through four seasons, padi "Bendang Serai," "Lebat Chantek," and "Jintan Kuning" have given the best results. "Jintan Puteh" produce a great quantity of straw, and is suitable for wetter situations than are supplied on the Experimental Plots. "Muntit" has already been stated to be a good padi. The seed is heavy, so that a gantang of grain gives good weight, and the percentage of grain to straw is satisfactory.

Of the padi tested for the second time in 1920, little can yet be said, except that there are indications that some very good strains may be isolated.

In the statement of results, it has been decided to show both weight and measure. The usual custom amongst Malays is to speak of padi in terms of "gantangs" (Imperial Gallon). The true measure of the worth of a padi is in weight, and for correct representation of the relative merits of different padi, this is the only possible factor in judging yield.

The weight of the straw and the estimation of the percentage of grain to straw is of value in the consideration of the yielding capacity of the padi. In the "tenggala" area, the average amount of straw produced is about 4,000 lbs. per acre, which gives about 15 per cent. grain to straw. In cases where the amount of straw is high, it suggests that the padi is more accustomed to wet conditions, and is capable, under conditions more favourable to itself, of giving higher yields. The padi, with the small amount of straw, such as is shown in Table 35, are found to be dry land padi. These therefore give a high figure for the percentage of grain to straw.

TABLE 16.

Lembut Ekor Kerbau.

Reference No. 1.

Year.	Plot No.	Weight per gantang padi.		Gantangs of padi per plot.	Estimated yield padi per acre.		Weight of straw per acre.	Remarks.
		lbs.	oz.		lbs.	Gtgs.		
1917	3	4	6	2	350	80	4,631	
"	19	4	5	7	1,207	280	5,320	
"	35	4	6	6 $\frac{1}{2}$	1,130	260	6,171	
1918	3	4	11	3 2 $\frac{1}{2}$	663	142	5,000	
"	19	4	7	6 1 1	1,132	255	8,724	
"	35	4	11	4 3 1 $\frac{1}{2}$	923	197	5,371	
1919	3	5	5	3 1 0	690	136	2,550	
"	19	5	2	4 0 0	820	160	4,256	Lodged
"	35	5	0	2 2 0	500	100	1,064	
1920	1	5	0	2 2 1	524	105	1,920	
"	15	5	0	1 3 0	350	70	2,600	
"	29	5	0	0 1 0	50	10	1,320	

TABLE 17.

Bendang Serai.

Reference No. 2.

Year.	Plot No.	Weight per gantang padi.		Guntangs of padi per plot.	Estimated yield padi per acre.		Weight of straw per acre.	Remarks.
		lbs.	oz.		lbs.	Gtgs.		
1917	6	5	13	2	465	80	4,416	
"	22	5	9	2	445	280	4,255	
"	32	5	9	5	1,112	200	5,852	
1918	6	5	7	4 2 1 $\frac{1}{2}$	1,017	187	5,958	
"	22	4	7	7 1 1 $\frac{1}{2}$	1,318	297	4,043	
"	32	5	1	4 3 1	937	195	3,724	
1919	6	5	9	1 2 0	334	60	2,979	
"	22	5	9	3 2 0	807	145	3,092	
"	32	5	8	3 1 1	742	135	3,724	
1920	2	5	7	1 3 0	376	70	2,560	
"	16	5	7	1 2 0	325	60	3,800	
"	30	5	7	0 1 0	53	10	520	

TABLE 18.

Jambak Bawang.

Reference No. 3.

Year.	Plot No.	Weight per gantang padi.		Gantangs of padi per plot.	Estimated yield padi per acre.		Weight of straw per acre.	Remarks.
		lbs.	oz.	G. C. L.	lbs.	Gtgs.	lbs.	
1917	9	5	4	2	420	80	3,618	Attacked by rats
"	25	5	6	5 $\frac{1}{2}$	1,182	220	5,054	
"	29	5	6	4 3 0	946	176	3,937	
1918	9	5	5	1 3 $\frac{1}{2}$	382	72	6,118	Attack coarctata
"	25	5	5	3 2 1	744	140	3,459	" "
"	29	5	5	5 0 $\frac{1}{2}$	1,073	202	4,894	
1919	9	5	7	2 1 0	490	90	3,830	Damage by pigs
"	25	5	10	3 1 1	759	135	4,522	Lodged
"	29	5	7	3 1 0	707	130	4,575	Lodged
1920	3	5	11	1 2 0	341	60	1,920	
"	17	5	11	2 0 0	455	80	3,480	
"	31	5	11	0 2 1	141	25	2,840	

TABLE 19.

Variety—Lenggok.

Reference No. 4.

Year.	Plot No.	Weight per gantang of padi.		Gantangs padi per plot.	Estimated yield padi per acre.		Estimated weight of straw per acre.	Remarks.
		lbs.	oz.	G. C. L.	lbs.	Gtgs.	lbs.	
1917	12	5	4	2 1 0	472	90	4,416	
"	26	5	6	4 3 0	1,021	190	4,362	
"	28	5	6	5 1 0	1,180	210	3,890	
1918	12	5	5	4 0 1	877	165	4,682	Attacked by birds and coarctata
"	26	5	5	4 3 1 $\frac{1}{2}$	1,047	197	4,788	
"	28	5	5	3 1 0 $\frac{1}{2}$	585	132	2,766	
1919	12	5	6	2 2 1	565	105	2,872	
"	26	5	10	2 1 1	535	95	4,309	Lodged
"	28	5	10	4 1 0 $\frac{1}{2}$	968	172	5,320	"
1920	4	5	11	3 1 0	739	130	2,920	
"	18	5	11	1 0 1	255	45	2,240	
"	32	5	11	0 1 1	86	15	800	

TABLE 20.

Variety—Lebat Ungoo.

Reference No. 5.

Year.	Plot No.	Weight per gantang of padi.		Gantangs padi per plot.	Estimated yield padi per acre.		Estimated weight of straw per acre.	Remarks.
		lbs.	oz.		lbs.	Gtgs.		
1917	15	5	13	1 3 0	407	70	4,309	Attacked by birds and coarctata
"	23	5	9	5 0 0	11,113	200	5,852	
"	31	5	9	5 0 0	1,118	200	4,256	
1918	15	5	7	2 3 0 $\frac{1}{10}$	609	112	6,065	
"	23	5	7	2 0 1 $\frac{1}{20}$	473	87	3,724	Attack pigs and lodged
"	31	5	7	2 0 1 $\frac{1}{20}$	473	87	5,958	
1919	15	5	10	2 0 0	438	80	2,606	
"	23	5	10	2 3 1	647	115	4,150	
"	31	5	10	4 0 0	900	160	4,628	
1920	5	5	8	2 1 1	523	95	2,680	
"	19	5	8	1 3 1	410	75	4,360	
"	33	5	8	0 1 0	43	10	120	

TABLE 21.

Variety—Lebat Chekor.

Reference No. 6.

Year.	Plot No.	Weight per gantang of padi.		Gantangs padi per plot.	Estimated yield padi per acre.		Estimated weight of straw per acre.	Remarks.
		lbs.	oz.		lbs.	Gtgs.		
1917	18	5	5	2 3 0	584	110	3,990	Lodged
"	20	5	13	4 1 0	988	170	5,746	
"	34	6	0	6 0 0	1,440	240	4,043	
1918	18	5	5	1 3 1 $\frac{1}{2}$	409	77	4,256	
"	20	5	5	1 3 0	372	70	3,586	
"	34	5	5	5 2 0	1,169	220	3,564	
1919	18	5	11	3 1 0	739	130	2,820	
"	20	5	11	3 2 1	825	145	3,937	
"	34	5	9	3 1 1	771	135	2,926	
1920	6	5	11	1 0 1	256	45	1,480	
"	20	5	11	1 3 0	391	70	2,920	
"	34	5	11	0 2 0	114	20	3,200	

TABLE 22.

Variety—Sunting Muar.

Reference No. 7.

Year.	Plot. No.	Weight of one gantang padi.		Gantangs padi per plot.	Estimated yield padi per acre.		Estimated weight of straw per acre.	Remarks.
		lbs.	oz.		lbs.	Gtgs.	lbs.	
1917	1	5	5	5	1,063	200	7,875	
"	17	5	5	4	850	160	8,241	Attack birds and coar- ctata
"	21	5	5	2	405	80	5,250	
1918	1	5	1	6 0 0 $\frac{1}{2}$	1,105	242	10,800	
"	17	5	1	4 0 0	811	160	6,384	Attack birds and coar- ctata
"	21	5	0	3 3 0	749	150	7,980	
1919	1	5	0	3 2 0	700	140	3,830	Slight attack and damage by pig attacks
"	17	5	0	3 2 0	700	145	2,660	No attacks
"	21	5	0	1 3 1	352	71	1,915	Slightly shaded by jungle
1920	7	5	0	3 3 1	773	155	2,600	
"	21	5	0	1 0 1	223	45	1,360	
"	35	5	0	0 0 $\frac{1}{4}$	attached			

TABLE 23.

Variety—Lebat Chantek.

Reference No. 8.

Year.	Plot. No.	Weight per gantang padi.		Gantangs padi per plot.	Estimated yield padi per acre.		Estimated weight of straw per acre.	Remarks.
		lbs.	oz.		lbs.	Gtgs.	lbs.	
1917	4	5	9	4 3 0	1,058	190	5,320	Bad attack by coarctata and birds
"	14	5	13	4 0 0	930	160	9,097	
"	24	5	0	2 3 0	582	110	4,937	
1918	4	5	10	5 1 0	1,210	215	9,682	
"	14	5	9	1 3 0	360	70	7,980	Attack coarctata and birds
"	24	5	5	5 3 0	1,220	230	3,884	
1919	4	5	8	2 0 0 $\frac{1}{2}$	451	82	2,660	Attack wild pig
"	14	5	10	4 2 1	1,041	185	3,511	No attacks
"	24	5	10	2 2 0	563	100	2,660	
1920	8	5	11	1 1 0	283	50	2,230	
"	22	5	11	3 2 0	793	140	5,080	
"	36	5	11	0 0 1	destroyed			

TABLE 24.
Variety—*Jintan Kuning*.
Reference No. No. 9.

Year.	Plot. No.	Weight per gantang padi.		Gatangs padi per plot.	Estimated yield padi per acre.		Estimated weight of straw per acres.	Remarks.
		lbs.	oz.	G. C. L.	lbs.	Gtgs.	lbs.	
1917	7	5	5	7 0 0	1,488	280	10,214	
"	11	5	5	4 3 0	1,010	190	8,725	
"	27	5	10	2 0 0	460	80	3,431	
"	37	5	13	7 0 0	1,627	280	4,788	
"	38	5	7	4 1 0	923	170	3,032	
1918	7	5	5	6 1 0	1,328	250	8,246	
"	11	5	5	1 2 0	319	60	7,076	Attack coarctata
"	27	5	2	0 1 0 $\frac{1}{2}$	62	12	5,320	Do. do.
"	38	5	2	1 0 0 $\frac{1}{2}$	215	42	3,045	Attack and birds
"	39	5	2	0 1 0 $\frac{1}{2}$	62	12	3,511	Do. do.
1919	7	5	2	2 0 1	421	85	4,362	Do. do.
"	11	5	2	5 0 0	1,025	200	3,086	
"	27	5	2	0 3 0	307	60	1,168	Shaded jungle
"	38	5	2	1 1 1	282	55	1,330	Attack coarctata
"	39	5	2	0 2 0 $\frac{1}{2}$	113	22	1,330	Do. do.
1920	9	5	8					
"	23	5	8					
"	37	5	8	Failed--the ears being empty.				
"	43	5	8					
"	44	5	8					

TABLE 25.
Variety—*Jintan Puteh*.
Reference No. 10.

Year.	Plot No.	Weight per gantang of padi.		Gatangs padi per plot.	Estimated yield padi per acre.		Estimated weight of straw per acre.	Remarks.
		lbs.	oz.	G. C. L.	lbs.	Gtgs.	lbs.	
1917	8	5	8	3 1 0	715	130	9,108	Slight attack by rats
"	10	5	8	6 0 0	1,320	240	10,852	
"	30	5	5	2 1 0	478	90	2,820	Shaded by jungle
1918	10	5	9	4 3 0	1,057	190	12,397	
"	8	5	3	5 2 0	1,140	220	6,158	
"	30	5	3	0 1 0	47	9	6,158	Do. do.
1919	8	5	9	5 0 0	1,056	200	4,469	
"	10	5	9	6 2 0	1,445	260	5,214	
"	30	5	9	0 3 1	362	65	2,660	Do. do.
1920		Failed.						

TABLE 26.

Variety—Nias.

Reference No. 11.

Year.	Plot No.	Weight per gantang of padi.		Gantangs padi per plot.	Estimated yield padi per acre.		Estimated weight of straw per acre.	Remarks.
		lbs.	oz.		lbs.	Gtgs.		
1917	5	5	8	1 1 0	275	50	5,213	Attack coarctata
"	13	5	5	2 3 0	584	110	4,628	
"	33	5	8	1 0 0	220	40	1,702	Shaded by jungle
1918	5	5	9	2 0 0	445	80	3,511	Slight attack rats
"	13	5	9	1 3 1 $\frac{1}{2}$	428	77	6,384	Attack coarctata, birds and rats
"	33	5	9	1 1 0	278	50	2,926	
1919	5	5	5	3 0 1	664	125	2,713	Slight destruction by pigs
"	13	5	5	3 3 1	770	145	3,032	
"	30	5	5	1 0 1	239	45	639	Shaded by jungle
1920	79	5	11	1 3 1 $\frac{1}{2}$	437	79	3,160	
"	93	5	11	0 2 0	113	20	2,080	

TABLE 27.

Variety—Nias.

Reference No. 12.

Year.	Plot No.	Weight per gantang of padi.		Gantangs padi per plot.	Estimated yield padi per acre.		Estimated weight of straw per acre.	Remarks.
		lbs.	oz.		lbs.	Gtgs.		
1917	2	5	8	2 2 0	550	100	4,256	Attack stem borer
"	16	5	11	3 0 0	682	120	3,992	Slight stem and rats
"	36	5	8	2 0 0	440	80	2,074	Shaded by jungle
1918	2	5	9	1 3 0 $\frac{1}{2}$	400	72	2,926	
"	16	5	9	3 0 0 $\frac{1}{2}$	670	122	5,586	
"	36	5	9	1 2 0	332	60	2,660	Shaded close jungle
1919	2	5	5	2 1 0	478	90	1,490	Damaged by wild pig
"	16	5	5	3 0 0	638	120	3,298	
"	36	5	5	0 1 0	53	10	1,064	Attack coarctata and shaded jungle.
1920	75	5	11	4 3 0	1,076	190	5,440	
"	94	5	11	0 1 0 $\frac{1}{2}$	70	12	1,960	

TABLE 28.

Variety—Galak Tegap.

Reference No. 13.

Year.	Plot No.	Weight per gantang of padi.		Gantangs padi per plot.	Estimated yield padi per acre in		Estimated weight of straw per acre.	Remarks.
		Lbs.	Ozs.		Lbs.	Gtgs.		
1917	49	6	1	1 2 0	364	60	2,207	Attack coarctata
1918	37	5	5	0 1 0	53	10	2,607	Attacked coarctata and birds
„	51	5	5	2 1 0 $\frac{1}{2}$	436	82	3,245	Close to jungle
1919	37	5	5	1 0 0	213	40	2,554	Bad germination
„	81	5	5	4 1 0	903	170	3,618	Crop lodged
„	51	5	5	2 2 1	580	105	2,688	Do.
1920	55	5	2	0 3 0	153	30	400	
„	84	5	2	4 0 0	825	160	2,120	

TABLE 29.

Variety—Sungkai.

Reference No. 14.

Year.	Plot No.	Weight per gantang of padi.		Gantangs padi per plot.	Estimated yield padi per acre in		Estimated weight of straw per acre.	Remarks.
		Lbs.	Ozs.		Lbs.	Gtgs.		
1917	49	5	10	1 2 0	337	60	2,288	Attack coarctata
1918	42	5	8	0 2 0	110	20	2,181	Close to jungle and attacked coarctata
„	52	6	8	2 3 0	605	110	6,012	Attack birds and coarctata
1919	42	5	9	1 1 $\frac{1}{2}$	289	52	372	Shaded by jungle
„	52	5	5	5 3 1	1,248	235	1,618	Part lodged
„	77	5	5	3 3 0	797	150	2,926	Lodged
1920	57	5	11	0 2 0	113	20	120	
„	89	5	11	0 2 1	140	25	800	

TABLE 30.

Variety—Emboon.

Reference No. 15.

Year.	Plot No.	Weight per gantang of padi.		Gantangs padi per plot.	Estimated yield padi per acre in		Estimated weight of straw per acre.	Remarks.
		Lbs.	Ozs.		Lbs.	Gtgs.		
1917	52	5	10	2 3 0	612	110	2,075	Attack coarctata
1918	44	5	13	0 3 1 $\frac{1}{2}$	99	17	4,628	Attack coarctata and birds
"	47	5	13	2 3 1 $\frac{1}{2}$	680	117	4,256	Attack coarctata and birds
1919	44	5	8	4 1 0	935	170	4,203	Lodged
"	47	5	8	2 2 1	578	105	3,501	Do.
"	84	5	8	2 2 1	578	105	2,820	Lodged attack birds
1920	59	5	14	1 1 1	324	55	1,840	
"	90	5	14	1 1 1	324	55	1,440	

TABLE 31.

Variety—Senggom.

Reference No. 16.

Year.	Plot No.	Weight per gantang of padi.		Gantangs padi per plot.	Estimated yield padi per acre in		Estimated weight of straw per acre.	Remarks.
		Lbs.	Ozs.		Lbs.	Gtgs.		
1917	51	5	1	2 3 0	557	110	2,075	Attacked coarctata
"	54	5	1	2 0 0	405	80	1,075	Coarctata and rats
"	54	5	1	0 3 0	152	30	953	Do. do.
"	56	5	1	1 0 0	203	40	1,383	Do. do.
1918	45	5	1	0 1 1	81	16	3,245	Do. do.
"	50	5	1	2 3 0	557	110	6,490	Do. do.
1919	45	4	13	1 3 1	361	75	1,155	Shaded by jungle
"	50	4	13	7 2 1	1,467	305	2,820	Lodged
"	80	4	15	4 3 1 $\frac{1}{2}$	973	197	5,239	Do.
1920	61	4	13	2 0 1	412	85	1,680	
"	74	4	13	3 3 1	749	155	3,200	

TABLE 32.
Variety—*Lembut Petai*.
Reference No. 17.

Year.	Plot No.	Weight per gantang of padi.		Gantangs padi per plot.	Estimated yield padi per acre in		Estimated weight of straw per acre.	Remarks.
		Lbs.	Ozs.		Lbs.	Gtgs.		
1918	17	5	5	0 1 0	58	11	3,352	Near jungle and attack birds, etc.
"	49	5	5	3 1 0 $\frac{1}{2}$	710	132	3,884	Near jungle and attack birds, etc.
1919	40	5	5	1 3 1	398	75	11,065	Coarctata
"	49	5	5	5 0 1	1,089	205	3,618	Do.
"	79	5	5	1 2 1	335	65	479	Do.
1920	81	5	5	5 1 1	1,145	215	3,480	
"	96	5	5	0 2 0	102	20	1,320	

TABLE 33.
Variety—*Muntit*.
Reference No. 18.

Year.	Plot No.	Weight per gantang of padi.		Gantangs padi per plot.	Estimated yield padi per acre in		Estimated weight of straw per acre.	Remarks.
		Lbs.	Ozs.		Lbs.	Gtgs.		
1918	41	5	13	5 0 1	1,192	205	6,278	Close jungle and attack birds, etc.
"	48	5	13	8 0 1	1,890	325	11,438	Attack pigs
1919	41	6	12	2 2 1	605	105	4,788	
"	48	5	12	5 2 0	1,265	220	2,554	
"	82	5	12	6 1 0	1,552	270	6,544	
1920	11	5	15	2 2 0	590	100	3,200	
"	25	5	15	5 0 0	1,183	200	3,400	

TABLE 34.
Variety—*Sri Pahang*.
Reference No. 19.

Year.	Plot No.	Weight per gantang of padi.		Gantangs padi per plot.	Estimated yield padi per acre in		Estimated weight of straw per acre.	Remarks.
		Lbs.	Ozs.		Lbs.	Gtgs.		
1918	43	5	5	2 1 0	478	90	3,990	Coarctata and birds
1919	43	5	5	3 0 1	876	165	1,915	Slight attack pigs
"	46	5	5	4 1 1	950	175	3,671	Lodged
"	78	5	5	4 2 1	983	185	3,352	Do.
1920	65	5	11	1 2 1	340	60	2,120	
"	91	5	11	5 1 0	1,190	210	1,600	

TABLE 35.

Yield of Padi tested two seasons—1919 and 1920.

Reference No.	Variety.	Year.	Plot.	Weight of one gantang padi seed.	Yield per plot in gantangs.	Estimated weight per acre of padi.	Yield per acre of padi in	Yield per acre of straw in
				lbs. oz.	G.C.L.	lbs.	Gt's.	lbs.
20	Pulut Dukang	1919	53	4 13	5 3 0	1,107	230	2,979
		"	72	4 13	3 3 0	722	150	4,309
		1920	67	5 3	1 1 0	253	50	1,880
		"	92	5 3	2 0 0	413	80	1,640
21	Ribu ...	1919	54	5 13	4 0 0	930	160	1,915
		"	71	5 13	2 0 0	465	80	4,628
		1920	64	5 13	2 1 0	523	90	1,600
		"	85	5 13	3 2 0	816	140	1,480
22	Jarum	1919	55	5 9	2 2 1	584	105	1,915
		"	70	5 9	5 1 1	1,196	215	4,362
		1920	51	5 11	1 3 1	428	75	2,683
		"	78	5 11	5 0 0	1,133	200	3,480
23	Alor Nibong	1919	56	5 13	3 3 0	884	150	2,234
		"	68	5 13	4 0 0	930	160	4,160
		1920	53	5 13	3 0 0	700	120	2,400
		"	70	5 13	1 3 0	408	70	640
24	Matau	1919	57	5 8	3 0 0	660	120	2,447
		"	69	5 8	3 0 1 $\frac{1}{2}$	693	126	3,404
		1920	54	5 9	2 2 0	566	100	1,080
		"	76	5 9	5 1 0	1,172	210	2,560
25	Lumut	1919	58	5 5	2 1 0	478	90	1,333
		"	67	5 5	5 1 0	1,115	210	3,245
		1920	52	5 0	5 0 0	1,000	200	1,600
		"	77	5 0	4 3 1	976	195	3,200
26	Choring	1919	59	5 5	4 3 0	1,009	190	2,341
		"	95	5 5	6 2 0	1,381	260	4,150
		1920	45	5 8	1 1 0	302	55	320
		"	68	5 8	0 2 0	110	20	1,920
27	Kuku Balam	1919	60	4 15	3 3 1	765	155	2,288
		"	73	4 15	3 0 0 $\frac{1}{2}$	627	127	8,033
		1920	46	5 0	2 0 0	425	80	2,120
		"	69	5 0	1 1 0	275	55	800
28	Anak Lebah	1919	61	5 10	3 2 0	788	140	2,288
		"	71	5 10	3 3 0	844	150	5,800
		1920	47	5 9	2 1 0	530	95	2,120
		"	95	5 9	0 1 1	85	15	1,600
29	Turun Daun	1919	62	5 5	3 2 0	744	140	1,383
		"	75	5 5	4 0 0	850	160	3,245
		1920	48	5 11	1 0 0	226	40	160
		"	82	5 11	5 1 1	1,215	215	4,240
30	Batang Mas	1919	63	5 5	3 1 0	691	130	1,915
		"	76	5 5	2 1 0	460	90	3,032
		1920	49	5 8	4 0 0	880	160	2,400
		"	71	5 8	1 0 0	220	40	440

TABLE 35—(cont.)

Yield of Padi tested two seasons—1919 and 1920—(cont.)

Reference No.	Variety.	Year.	Plot.	Weight of one gantang padi seed.	Yield per plot in gantangs.	Estimated weight per acre of padi.	Yield per acre of padi in	Yield per acre of straw in
				lbs. oz.	G.G.L.	lbs.	Gt's.	lbs.
31	Bunga Me-machang	1919	64	5 5	6 2 0	1,381	260	6,965
		"	88	5 5	8 0 0	1,700	320	7,129
		1920	12	5 8	1 3 1	412	75	5,880
		"	26	5 8	1 1 1	302	55	2,360
32	From Planters' Stores, Klang	"	40	5 8	1 1 0	275	50	3,200
		1919	65	5 10	3 3 1	872	155	10,852
		"	66	5 10	4 3 1	1,117	195	9,948
		1920	Crop failed.					
33	From Sime Darby & Co.	1919	98	4 10	3 1 1	540	135	1,692
		1920	50	4 12	1 3 0	347	70	5,320
		"	72	4 12	0 1 1	73	15	160
		1919	97	7 10	2 3 1	647	115	8,618
34	Terong Chandana	"	99	5 10	2 0 0	450	80	8,565
		1920	Three plots—Crop failed.					

TABLE 36.

Average of Yields of Padi.—Four seasons 1917-1920.

Ref No.	Variety,	Weight per Gantang.	Yield per acre in	Weight of straw per acre.	Per-centage of grain to plant	
		lbs. oz.	lbs. gant's.	lbs.		
	Lembut Ekor					
	Kerbau... ..	4 12	695	149	4,082	14.5
2	Bendang Serai ...	5 8	665	127	3,744	15.1
3	Jambak Bawang ...	5 7	637	117	4,021	13.7
4	Lenggok ...	5 7	694	129	3,614	16.1
5	Lebat Ungoo ...	5 8	496	108	4,059	12.8
6	„ Chekor ...	5 8	672	120	3,539	15.9
7	Sunting Muar ...	5 1	703	141	5,354	11.6
8	Lebat Chantek ...	5 9	772	139	5,185	12.9
9	Jintan Kuning ...	5 7	642	118	4,577	12.3*
10	„ Puteh ...	5 7	841	154	7,259	10.4*
11	Nias 1 ...	5 8	405	74	3,272	11.0
12	„ 2 ...	5 8	482	90	3,159	13.3
13	Galak Tegap ...	5 6	441	82	2,430	15.3
14	Sungkai ...	5 8	454	84	2,040	18.2
15	Emboon ...	5 11	516	92	3,107	14.2
16	Senggom ...	4 15	538	909	2,665	16.7

* The 1920 figures are not included, as the crop completely failed in that year.

TABLE 37.

Average of Yields of Padi.—Three seasons 1918-1920.

Ref. No.	Variety.	Weight per Gantang.	Yield per acre in		Weight of straw per acre.	Per- centage of grain to plant.
		lbs. oz.	lbs.	gant's.	lbs.	
17	Lembut Petai ...	5 5	548	103	3,885	12.4
18	Muntit ...	5 13	1,782	203	5,457	17.8
19	Sri Pahang ...	5 7	799	148	2,774	22.3

TABLE 38.

Average of Yields of Padi.—Two seasons 1919 and 1920.

Ref. No.	Variety.	Weight per gantang of padi in	Estimated yield per acre in		Estimated weight of straw per acre.	Percent- age seed padi to plant.
		Lbs. Oz.	Lbs.	Gant's.	Lbs.	
20	Pulut Dukong ...	5 0	624	127	2,702	18.7
21	Ribu ...	5 13	683	117	2,406	22.1
22	Jarun ...	5 10	835	149	3,109	21.2
23	Alor Nibong ...	5 13	730	125	2,358	23.6
24	Mutan ...	5 8	773	139	2,373	24.5
25	Lumut ...	5 2	892	174	2,357	27.4
26	Choring ...	5 6	700	131	2,183	24.2
27	Kuku Balam ...	5 0	523	104	2,810	15.7
28	Anah Lebah ...	5 9	562	100	2,952	16.0
29	Turun Daun ...	5 8	759	139	2,257	25.1
30	Batang Mas ...	5 6	562	105	1,947	22.4
31	Bunga Memachang	5 7	814	190	5,107	13.7
33	Sime Darby & Co.	4 11	320	73	2,391	11.8

TABLE 39.

Average of Yields of Padi.—Tested in one season only.

Ref. No.	Variety.	Weight per gantang of padi in	Estimated yield per acre of padi in		Estimated weight of straw per acre.	Percent- age seed padi to plant.
			Lbs. Oz.	Lbs.	Gant's.	Lbs.
32	Planters' Stores (1919)	5 10	994	175	10,400	8.7
34	Terong Chandana (1919)	5 10	548	97	8,591	6.0
35	Tanon Dukong (20)	5 11	355	60	1,080	
36	Telor Bujuk ...	5 7	203	37	240	
37	Changgai Petai ...	4 13	748	157	2,040	
38	Gunong Berangkat	5 12	590	102	1,320	
39	Jolok Kait... ..	5 5	386	72	2,580	
40	Jabak	5 11	40	7	840	
41	Inche Mandak ...	5 12	143	25	240	

BOTANICAL FEATURES.

The botanical features and classification of "padi tenggala" is admittedly, very incomplete. The compilation of such matter necessitates the constant presence of the investigator, and under the present conditions, it has been impossible for the writers to give this work their undivided attention. The more obvious differences of the features of the growing crop, in the case of the first seventeen varieties under test are given in the table below, and the results of the observations of inflorescence in table 42.

The study of the differences in racime, padi and husked grains has been given closer investigation. In comparison with "wet padi," the racime of "padi tenggala" is short, and there are fewer seeds per racime. Padi "Lebat Chekor" is a notable exception, being equal in this respect to the best of the wet padi.

Most of the padi tenggala are short grained varieties. The form and appearance of those of "hill padi" origin is, in most cases, superior to those varieties of a purely "tenggala nature," or the more hardy varieties such as can be used either as hill, "tenggala" or wet padi.

Observation on the Grain of *Tenggala Padi*.

Ref. No.	Variety.	Racine length.	No. of per racime.	Spike-lets on base of racime.	No. of grains per grain.		Unhusked grain.		Husked grain.		Average weight of 100 husked seed (grams).	Remarks.
					Full grain.	Empty grain.	Length cms.	Width cms.	Length cms.	Width cms.		
1	Lembut Ekor Kerbau	24.6	13.0	2.0	172	20	.93	.25	.70	.20	1.78	
2	Bendang Serai	23.2	11.0	.5	144	14	.93	.25	.68	.22	1.86	
3	Jambak Bawang	26.7	15.0	1.6	217	22	.95	.30	.68	.22	1.79	
4	Lenggok	23.7	12.9	1.0	134	17	.88	.30	.65	.23	1.69	
5	Lebat Ungoo	20.7	10.7	.4	143	17	.85	.25	.65	.20	1.57	
6	Lebat Cekor	23.3	14.2	2.3	276	41	.77	.25	.63	.20	1.42	
7	Sunting Muar	23.8	9.9	.6	111	14	1.00	.20	.68	.20	1.41	
8	Lebat Chantek	22.6	14.0	2.0	229	27	.84	.33	.65	.28	1.93	
9	Jintan Kuning	18.7	10.5	.6	116	11	.83	.26	.65	.20	1.46	
10	Jintan Putih	24.3	12.3	1.6	222	30	.83	.21	.65	.20	1.59	
11	Nias 1	25.2	14.1	.6	162	16	.82	.28	.65	.23	1.63	
12	Nias 2	22.7	11.6	.0	98	15	.94	.31	.73	.23	2.21	
13	Galak Tegap	24.0	12.7	.5	159	15	.96	.25	.73	.20	1.85	
14	Sungkai	25.2	13.0	.7	139	22	.86	.34	.67	.25	2.33	
15	Emboon	22.8	13.7	.8	225	34	.86	.34	.67	.25	2.33	
16	Senggom	28.4	13.6	1.2	172	24	1.00	.25	.85	.20	1.78	
17	Lembut Petai	25.3	14.1	.7	173	18	.93	.32	.68	.23	2.74	
18	Muntit	22.0	14.8	2.5	227	36	.76	.30	.53	.23	1.71	
19	Sri Pahang	25.0	16.6	1.1	141	30	.88	.28	.67	.19	2.09	
20	Pulut Dukong	26.3	16.0	1.3	199	42	.90	.31	.65	.25	2.26	
21	Ribu	22.6	13.5	1.0	182	34	.75	.30	.55	.23	1.78	
22	Jarum	23.0	11.6	1.2	199	20	.85	.28	.63	.22	1.88	
23	Alor Nibong	21.1	15.6	1.3	162	36	.75	.30	.54	.24	1.58	
24	Mutan	23.9	12.7	1.5	140	12	.89	.27	.64	.18	1.64	
25	Lumut	29.4	17.4	1.2	156	70	1.05	.20	.69	.15	1.71	
26	Choring	30.0	15.2	1.1	178	71	.80	.31	.63	.26	2.07	
27	Kuku Balam	28.0	18.1	1.3	194	53	1.04	.16	.75	.15	1.78	
28	Anak Lebah	23.6	15.0	1.1	179	39	.78	.31	.58	.24	1.70	
29	Turun Daun	24.8	15.9	1.0	148	65	.86	.25	.63	.20	1.85	
30	Batang Mas	26.1	16.8	1.0	194	47	.92	.24	.68	.20	1.78	
31	Bunga Memachang	22.9	11.9	1.3	133	26	.83	.30	.55	.22	1.50	
32	Planters' Stores, Klang	30.1	15.2	3.5	181	87	1.00	.30	.66	.24	1.77	Type 1
33	Sime Darby & Co.	23.4	11.4	1.6	78	42	.88	.25	.62	.23	2.09	" 2
34	Terong Chandana	25.7	12.0	1.0	182	41	.65	.25	.38	.20	1.18	

Type 1. Purple awns and a red cuticle. Endosperm white.

" 2. White awns and white cuticle and endosperm.

DISTRICT AGRICULTURAL SHOW AT KUALA KANGSAR, PERAK.

A very successful agricultural show was held in the hall of the Malay College, Kuala Kangsar on 25th June. The arrangements proved adequate for the staging of the large number of exhibits, which facilitated the work of the judges.

The show was opened at 2 p.m. by His Highness The Sultan of Perak, and a large crowd of Malays immediately sought admission. The entries totalled over 3,000, of which padi and rice claimed over 800 entries. The general quality of the padi and rice . . . was good, although the varieties were, in many cases, of a mixed character.

The Department of Agriculture, F.M.S. and S.S., demonstrated the quality of the pure lines of padi grown on the Titi Serong Rice Experiment Station, Krian and the Superintendent of Government Plantations, Kuala Kangsar, exhibited fibre obtained from *Hibiscus sabdariffa* var. *Altissima* (Roselle fibre).

Vegetables were represented, and considering that almost all of the exhibits were grown by Malays, the quality was fairly satisfactory.

The fruit season at Kuala Kangsar was not good, which was reflected in the quality of the exhibits. Bananas and pineapples were shown in large numbers, and the quality was good.

There was keen competition in the classes for buffaloes, for substantial prizes presented by His Highness The Sultan. Poultry too, attracted many entries and the eggs were extremely satisfactory. The show of flowers was disappointing both in the quantity and quality of the exhibits.

D. H. G.

WORK OF THE INSPECTION STAFF

APRIL 1st TO JUNE 30th, 1921.

By F. W. SOUTH.

STAFF CHANGES AND APPOINTMENTS.

R. J. Fairweather proceeded to Malacca and took up his duties as Assistant Agricultural Inspector, Malacca and Singapore. By an arrangement between the Governments of the Federated Malay States and Johore, Mr. A. G. G. Ellis was temporarily seconded as Agricultural Inspector, Johore. The Assistant Agricultural Inspector, Pahang North, transferred his headquarters with the approval of the Director from Kuala Lipis to Raub as the latter place is more central and convenient for his work. Two new Assistant Agricultural Inspectors for the Federated Malay States reported in Kuala Lumpur for duty during the quarter.

A staff of Special Field Officers to supervise special work for the better control of Mouldy Rot Disease in Negri Sembilan was engaged during the quarter from among unemployed planters. It is expected that two additional officers will be engaged during the coming quarter.

An officer has also been appointed to a similar position by the Johore Government for the control of rubber diseases, especially Mouldy Rot and Pink Disease, in Northern Johore.

Fifty two estates in various parts of the country were visited by the Assistant Agricultural Inspector during the quarter.

NOTIFIABLE DISEASES OF RUBBER.

Pink Disease.—This disease was newly reported by one estate in Perak North, two estates in Perak South, one estate in Selangor and four estates in Negri Sembilan. Owing to two factors, viz., suitable damp weather in April and May, and the increase in the number of abandoned holdings, this disease has become more prevalent than usual in parts of Perak and Selangor; the districts especially affected are Batang Padang, Ulu Selangor, and Ulu Langat. Arrangements are nearly completed for enforcing more efficient treatment and control.

In Negri Sembilan the attacks are more sporadic and less severe. They are generally isolated and confined to young clearings and, on the whole, receive prompt attention.

In Pahang, Pink Disease is generally present, but not to so great an extent as in Perak or Selangor. It is not causing very serious damage in spite of the large number of abandoned rubber holdings present in some districts.

In the Colony the treatment of the disease in Province Wellesley has received attention and Malacca has remained free from the disease.

In Johore the presence of the Agricultural Inspector and the appointment of the special new officer will increase the efficiency of the control work. The disease is more prevalent in the north than in the south of Johore.

Mouldy Rot Disease.—Three unemployed European planters were engaged during the quarter for the special purpose of enforcing an improved control of this disease in Negri Sembilan. One is stationed in Rembau sub-district, one in Kuala Pilah district and one in Jelebu district. The behaviour of this disease has varied greatly in different districts. In Seremban district it had greatly diminished in virulence and distribution up to the middle of the quarter, there being only a few badly neglected holdings near Rantau in which the disease existed in an active form. At the beginning of June the disease began to appear and spread rapidly until at the close of the quarter it was present again around seven different centres. Its spread has been encouraged undoubtedly by the presence of lalang and blukar on many holdings and by the deep tapping commonly practised in an attempt to make higher yields compensate for the low price of rubber where tapping is still continued. Thinning, out on over-crowded holdings is usually beyond the owners' means. A curious feature is that both in the Seremban and Rembau districts, where the disease also re-appeared strongly during June the increase occurred in dry weather following on a long spell of weather when the rainfall was either average or somewhat high. In Kuala Pilah district the disease has been present throughout the quarter without any apparent signs of abatement; this is in spite of the fact, that the rainfall throughout the quarter was considerably lower than in the previous months and that the presence of an European Officer in the district has resulted in much more regular treatment of the disease. In Jelebu district and in Temerloh district of Pahang the disease has not spread. Several holdings are infected in Jelebu district, but are receiving attention and the Special Field Officer has been successful in getting a lot of work done in the form of painting, weeding, and thinning out; in this district the rainfall has been low. In Temerloh only six holdings are infected and all are under treatment. The Coast district remained practically free from this disease. The present distribution of the disease in this State is very exactly known.

In Johore the disease spread to within a few miles of Johore Bahru. Certain complaints regarding the failure of small holders to treat the disease adequately have received attention. In Segamat the closing down of holdings has tended to reduce the prevalence of the disease. It is to be expected that the arrival of the Agricultural Inspector and the appointment of a Special European Officer will result in more careful treatment of this disease than it has been possible to enforce with the limited staff available in the past.

Black Stripe.—There were no new reports of this disease from estates. During the first quarter of the year the disease was present in an epidemic form in the Jelebu district of Negri

Sembilan, one European estate being very badly infected. It is gratifying to note, however, that at the close of the second quarter practically no evidence of this disease can be found in the district. Possibly this is largely due to the comparatively dry weather prevailing throughout the quarter. There was no special mention of this disease elsewhere.

COCONUT PESTS AND DISEASES.

Brachartona catoxantha.—Fairly numerous attacks of this caterpillar have been recorded during the quarter; they occurred at two localities in Province Wellesley, two in Krian, one in Kinta, one in Kuala Selangor district and one near Johore Bahru. In the majority of cases the attacks have not been serious and the pest has been controlled quite successfully by its natural enemies alone, more especially by a fungus. The attack at Telok Ayer Tawar in Province Wellesley has been more serious. It occurred first on some very tall trees on about quarter acre of land but subsequently spread, and now involves about 200 acres of coconuts. The measures used for combatting the pest have included netting the moths and spreading the parasite fungus both by pinning infected leaves from other localities into the trees and by spraying smaller trees with water containing the fungus taken from pure cultures. These measures have met with some degree of success, but this attack cannot be said to be yet under satisfactory control. Further work is being continued.

Beetles.—There have been no particular reports of outbreaks of these pests in the Federated Malay States except that they are still giving trouble around Seremban, owing to the number of cattle stalls in parts of the outskirts and to accumulations of refuse in places. Much work has been done, but it is difficult to get all suitable accumulations of rubbish where black beetles breed, properly destroyed or disposed of.

In the Colony active measures for the destruction of breeding places for beetles have been continued, particularly in Malacca, and satisfactory results are gradually being obtained. In the island of Singapore much more active work is required and this point will receive attention.

In Johore beetles have not caused serious trouble.

An incinerator built of kerosine tins filled with earth was erected by the Chief Agricultural Inspector and the Government Entomologist for experimental purposes at Alor Gajah in Malacca. This will form the subject of a separate report.

White Ants.—These destroyed a certain number of trees in Negri Sembilan causing symptoms that were similar to those caused by bud-rot. The presence of bud-rot proper was not proved and the damage was certainly due in the first instance to the insects.

Leaf Disease.—In Negri Sembilan during April leaf disease was found, which threatened to cause serious damage. It was noted that the basal portion of attacked leaves became discoloured and the pinnae withered from the top downwards; subsequently after a short interval the whole frond collapsed and hung down the trunk, remaining suspended lightly at the point of attachment. Young and old fronds were attacked. The Mycologist was informed of the existence of the disease and commenced investigations as to its cause. This condition of coconut trees was noted throughout the State, but was later found that no serious damage had resulted.

PADI PESTS.

Stem Borers.—It has been found that these insects are very prevalent in parts of Krian in the young shoots that have arisen from old padi stubble and in young self-sown plants both of which are commoner than usual on account of the wet season recently experienced. Arrangements are being made to have all padi stubble and scattered plants dug up and burnt this year, as a measure of pest control before the land is replanted. This course is not advocated as a general practice, because valuable manure is wasted and parasites of the borers are also destroyed, but this year it is justified by exceptional circumstances and should form a useful large-scale experiment.

WATER HYACINTH.

Work has been of a routine nature in Krian and calls for no special comment.

The Assistant Agricultural Inspector, Malacca, reports that he does not consider that this plant is a serious pest in Malacca. He has been able to arrange with the Executive Engineer for its removal from Government drains when it is present in large quantities.

GENERAL.

The larvae of a dipterous insect were found burrowing in the skins of limes in Perak and causing the fall of a number of immature fruit. Specimens were sent to the Entomologist for examination. Specimens of minor pests on certain fruit trees and on sugar cane have also been sent to the Entomologist.

Experiments for destroying sensitive plant (*Mimosa pudica*) by spraying it with arsenite of soda solution have been started in Pahang where this plant is occasionally a nuisance, especially on padi land.

In Malacca the destruction of dead coconut and rubber stumps and timbers on the road reserves and on Crown land has proceeded in the Northern district. In the coming quarter work will be commenced in the other two districts as labour and supervision will permit and will be continued steadily.

**PRECIS MINUTES OF A MEETING OF THE ADVISORY
COMMITTEE DEPARTMENT OF AGRICULTURE.**

HELD AT THE OFFICE OF THE DIRECTOR OF AGRICULTURE, ON
SATURDAY, 18TH JUNE, AT 10 A.M.

PRESENT: Acting Director of Agriculture (Mr. B. J. Eaton, O.B.E.) in the chair, Hon'ble Mr. R. C. M. Kindersley, Mr. Fauconnier, Mr. Armstrong, Mr. G. W. B. Gray, Mr. Shelton-Agar, Mr. C. Ritchie, Mr. Eric Dickson (District Officer, Klang), Towkay Lee Kong Lam and Assistant to Director (Mr. F. de la Mare Norris), Secretary.

ABSENT: Mr. R. J. B. Clayton (District Officer, Lower Perak), Mr. W. S. Cookson, Mr. J. Bruce and Mr. H. J. Gillespie.

The following attended the meeting.

Mr. F. G. Spring (Agriculturist), Mr. B. Bunting (Agriculturist, Government Plantations), Mr. D. H. Grist (Agricultural Instructor), Mr. R. O. Bishop (Agricultural Chemist) and Mr. J. N. Milsum (Assistant Agriculturist).

1.—MINUTES.

The minutes of the Meeting held on 6th December, 1920, having been circulated, are taken as read and confirmed.

2.—PROGRESS REPORTS.

In connection with the Progress Report of the Inspection Staff, the Acting Director of Agricultural gives the meeting a brief account of proposals to deal with the control of Rubber diseases on small native holdings, many of which were understood to be at present abandoned owing to the inability of owners to pay for their up-keep.

The Committee is of the opinion that District Associations should be informed of these proposals. It was agreed to do this.

3.—LARGE SCALE EXPERIMENTAL FARM, SERDANG.

In connection with the large Scale Experimental Farm, the Acting Director of Agriculture, informs the meeting that the Honourable the Chief Secretary has visited Serdang, and that it was hoped that the construction of a road and of a temporary bungalow, which had been temporarily held up, would now be proceeded with immediately. The planting programme for 1921 had been circulated, and though a few of the proposed items would be behind hand, it was probable that we should be ahead of it in many respects.

A discussion of various items of this programme follows, the question of fibre production receiving considerable attention.

Amongst other crops receiving attention are Tea, Cocoa, Patchouli, fodder grasses, cardamoms, cotton, various varieties of which had been obtained by Mr. Sands from the West Indies, Sisal and Mauritius hemp, Coffee, African Oil Palm, Sugar (many good varieties of which had been received from Java) and Limes.

4.—AGRICULTURAL INSTRUCTION DIVISION.

The Acting Director of Agriculture informs the Committee that Mr. Grist, Agric. Instructor had visited Ceylon and studied existing methods of Agricultural Education instruction of natives; as a result of his visit, a scheme had now been drawn up and submitted to Government. This scheme included amongst other things, school gardens in vernacular and other schools and an Agricultural School.

5.—VISIT TO AFRICAN OIL PALM PLANTATION IN SUMATRA.

Mr. Milsum, Assistant Agriculturist gives the Committee a short account of his visit to Sumatra and informs the Committee that he has prepared a report on this subject. The necessity for artificial pollination of the Oil Palm is then discussed, and it is suggested that a demonstration of this should be given at the next Meeting of the Committee; also a demonstration of budding and grafting of Hevea.

The Director of Agriculture reads a note received from the District Officer, Klang in connection with the utilization of Palm Oil as fuel in the Congo.

6.—CINCHONA.

The correspondence relating to the cultivation of Cinchona having been circulated, Members are asked to express any views they may have on the subject, Memoranda prepared by the Honourable Mr. R. C. M. Kindersley and Mr. Armstrong are placed before the Meeting. The meeting is of the opinion that the cultivation of Cinchona should be undertaken on a large scale. It is proposed that a Scientific Officer of the Department of Agriculture should visit both Java and India, if possible, and obtain all possible information on cultivation, etc., the final selection of a suitable area could then be undertaken.

7.—PROPOSED DEPUTATION TO THE CHIEF SECRETARY.

The question of the necessity for this deputation is discussed.

8.—GENERAL.

It is decided, if possible, to hold the next Meeting towards the end of July, and it is suggested that this should include a visit to the Serdang Experimental Plantation.

The Meeting terminates at 12.30 p.m.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	TEMPERATURE.				HYGROMETER.				Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
			Mean Dry Bulb.	Maximum.	Minimum.	Range.	Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.			
Kelantan, Kota Bharu	...	145.46	82.3	90.63	73.56	17.06	76.8	.807	72.8	73.	...	1.13	.70
Pahang, Kuala Lipis	...	...	82.15	85.00	72.40	12.60	76.88	...	...	...	...	4.96	1.62
Johore, Johore Bahru	...	...	...	88.98	73.16	15.82	...	...	...	...	...	8.62	2.15
Singapore, Kandang Kerbau	1010.4	159.0	83.1	88.5	74.9	13.6	75.5	.905	...	81.	Calm	7.98	2.21
Malacca, Durian Daun	1017.6	139.0	82.0	84.0	74.0	10.0	76.0	.925	...	82.	N.E.	5.23	1.41
Negri Sembilan, Seremban	...	149.2	80.2	83.9	71.8	12.1	76.6	.881	75.3	85.8	...	5.73	1.92
" Kuala Pilah	...	156.6	82.6	90.8	...	...	80.0	.973	77.4	86.8	...	3.34	1.18
" Port Dickson	...	117.03	82.8	89.06	73.4	15.66	78.2	.886	75.2	77.9	...	4.03	1.14
Selangor, Kuala Lumpur	29.808	...	80.8	89.9	72.8	17.1	77.1	.862	74.7	81.	S.E.	6.61	2.36
" Klang	...	...	81.0	86.5	74.3	12.2	77.8	...	...	...	...	6.12	1.27
" Kuala Selangor	...	...	...	90.0	74.7	15.3	...	...	...	...	...	6.40	2.08
" Rawang	...	...	...	90.6	79.8	10.8	...	...	...	...	...	8.58	1.57
Perak, Telok Anson	...	...	82.68	93.0	72.0	21.0	78.20	.908	...	83.	...	6.49	1.33
" Ipoh	...	...	82.63	95.0	71.0	24.0	76.41	.828	73.64	75.	...	9.17	2.44
" Taiping	...	112.0	82.18	93.0	71.0	22.0	78.74	.937	...	87.	...	12.40	2.67
" The Cottage	...	...	...	...	...	...	...	...	...	...	...	17.75	2.75
" Parit Buntar	...	...	82.80	93.0	70.0	23.0	78.03	.997	...	81.	...	3.97	1.14
Penang, George Town	...	149.3	84.1	92.0	72.5	19.5	78.3	.892	...	76.7	N.W.	2.63	.51
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	3.89	1.26
Perlis, Kangar	...	...	...	91.23	73.57	17.66	...	...	...	...	...	3.19	.66

Abstract of Meteorological Readings in the various districts of Malaya for the month of May, 1921.

District.	Mean Barometrical Pressure at 32° Fah.	TEMPERATURE.				HYGROMETER.				Prevailing Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
		Maximum in Sun.	Mean Dry Bulb.	Maximum.	Minimum.	Range.	Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.		
Kelantan, Kota Bahru ...	...	144.19	82.8	91.45	74.58	16.87	77.7	.846	74.2	75.	6.53	1.33
Pahang, Kuala Lipis ...	...	...	81.49	89.25	75.49	13.76	76.28	...	...	...	9.81	3.01
Johore, Johore Bahru ...	...	...	...	88.37	73.80	14.57	...	...	...	...	12.12	3.25
Singapore, Kandang Kerbau ...	1013.6	...	81.7	84.5	77.9	6.6	78.3	.932	...	85.6	2.91	1.73
Malacca, Durian Daun ...	1017.7	138.0	81.0	87.0	74.0	13.0	77.0	.915	...	83.	10.86	3.03
Negri Sembilan, Seremban ...	...	149.3	80.5	88.3	72.4	15.9	78.5	.904	86.5	86.5	9.33	2.75
" Kuala Pilah ...	...	158.5	82.2	91.1	...	...	80.1	.964	77.5	88.8	3.13	1.72
" Port Dickson ...	...	126.7	82.5	88.4	74.3	14.1	74.9	.875	75.3	79.3	7.70	2.32
Selangor, Kuala Lumpur ...	2976.9	...	81.4	90.3	73.6	16.7	77.8	.815	75.2	82.	5.95	2.67
" Klang ...	...	...	80.7	85.9	74.7	11.2	77.2	...	...	...	4.32	.88
" Kuala Selangor ...	...	...	...	90.2	73.6	13.4	...	...	...	...	1.60	.53
" Rawang ...	...	...	...	90.1	79.2	10.8	...	...	...	...	2.16	.59
Perak, Telok Anson ...	...	...	83.22	92.0	72.0	20.0	78.65	.917	...	81.	5.66	2.08
" Ipoh ...	...	...	82.12	94.0	71.0	23.0	77.20	.870	74.22	81.	6.85	1.77
" Taiping ...	...	...	82.02	92.0	73.0	19.0	78.94	.947	...	87	18.91	4.17
" The Cottage ...	...	111.0	...	...	...	...	...	...	...	...	33.85	3.66
" Parit Buntar ...	...	...	82.40	92.0	72.0	20.0	78.34	.915	...	83	8.18	2.16
Penang, George Town ...	1008.4	155.0	82.1	93.0	70.0	23.0	77.7	.889	72.0	80.7	18.34	3.74
Kedah, Alor Star ...	...	...	...	...	...	...	...	...	...	...	18.67	2.22
Perlis, Kangar ...	...	...	...	88.51	74.77	13.74	...	...	...	...	15.36	2.36

District.	Mean Barometrical Pressure at 32° Fah.	TEMPERATURE.				HYGROMETER.				Prevailing Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
		Maximum in Sun.	Mean Dry Bulb.	Maximum.	Minimum.	Range.	Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.		
Kelantan, Kota Bharu ...	...	143.15	83.1	91.70	73.93	17.76	77.3	.823	73.4	73.	3.68	1.10
Pahang, Kuala Lipis ...	...	...	80.7	88.93	76.66	14.27	75.8	...	...	...	6.81	1.80
Johore, Johore Bharu ...	...	...	...	87.10	74.11	12.99	...	...	...	...	5.48	.74
Singapore, Kandang Kerbau ...	1013.4	...	81.2	83.1	71.7	11.4	75.5	.891	...	86.	2.65	1.10
Malacca, Durian Daun ...	1017.8	134.0	81.0	87.0	74.0	13.0	77.0	.904	...	85.	10.70	3.77
Negri Sembilan, Seremban ...	...	150.5	79.5	84.5	72.3	12.2	76.8	.885	74.0	86.3	8.74	2.44
" Kuala Pilah ...	...	158.7	82.9	91.3	...	...	77.3	.984	77.9	84.4	6.44	1.11
" Port Dickson ...	...	112.9	81.4	88.4	74.0	14.4	77.7	.871	75.1	79.7	15.38	3.41
Selangor, Kuala Lumpur ...	2976.9	...	81.2	90.2	72.3	17.9	77.4	.876	75.1	82.0	3.49	.91
" Klang ...	...	...	80.5	85.2	74.2	11.0	77.2	...	...	...	2.16	.98
" Kuala Selangor ...	...	...	...	90.2	76.5	13.7	...	...	...	...	3.76	2.04
" Rawang ...	...	...	...	89.5	70.4	19.1	...	...	...	...	1.60	.42
Perak, Telok Anson ...	...	...	...	92.0	72.0	20.0	76.3	.823	...	75.0	2.28	1.50
" Ipoh ...	...	...	82.89	95.0	72.0	25.0	77.0	.862	74.9	79.0	1.29	.27
" Taiping ...	...	112.0	83.58	94.0	73.0	21.0	79.6	.959	...	85.0	1.77	.86
" The Cottage ...	...	...	...	...	...	...	...	...	...	...	9.33	2.99
" Parit Buntar ...	...	...	83.87	93.0	72.0	21.78	71.0	.913	...	79.0	1.18	.59
Penang, George Town ...	1005.6	158.0	84.4	93.0	72.0	21.0	78.8	.913	72.0	77.6	5.50	2.71
Kedah, Alor Star ...	...	...	...	...	...	...	...	...	...	...	8.15	2.65
Perlis, Kangar ...	...	...	...	89.33	74.43	14.90	...	...	...	...	5.36	.87

